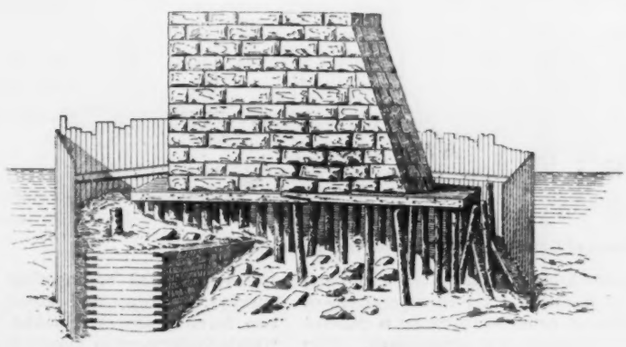
Repair of Bridge Pier at Kansas City, Mo.

BY G. W. PEARSONS.

Kansas City is at the junction of the Kansas and Missouri rivers: in its prehistoric days,(30 years ago or more), attempts were made to bridge the Kansas near its mouth. The bottom is alluvium, of unknown depth; log cribs were sunk on this bottom, bridges were built on them, and when ice gorges in the Kansas broke, (they have been known to gorge the Missouri, and raises it seventeen feet in a day) they were swept away, tradition stating that two or three of these have followed each other into the Missouri. Finally these log cribs were replaced by stone piers, founded on piles cut off at low water mark, and covered with grillage, these have stood the floods and ice gorges for twenty years or more and though disused of late years, owing to change of road, have been considered as first class work in all respects.

Recently these piers were purchased by the National Water-Works Company,of New York for the purpose of carrying water mains across the Kansas river, in connection with the change of water supply, from the Kansas to the Missouri river.

To make them secure above all known floods they were raised nine feet, with masonry, the added weight upon each pier being about 100 tons; in this condition they stood during the summer and showed no sign of failure till the superstructure was placed upon them; then the west channel pier gave way, sinking most at a point about one-third its length from the upper end, the head being thrust upstream by the sinking.



Kansas City Bridge Pier Repairs.

It being late in the season, the conditions with regard to low water,were favorable for repairs, but the necessity of securing the superstructure, and the liability of a coffer dam being destroyed by ice, made it necessary to work quick and with such material as was at hand, the false work used in erecting the iron bridge being available enabled the work to proceed without delay.

Western river water in its natural condition is opaque, what could not be told by sounding must be done by feeling, and a diver to be useful in such a place, must have the faculty of using his hands for eyes. Mr. Owens, of St. Louis,who was employed for the work, proved to have that ability.

The water was 22 feet deep on the west side of the pier; 15 to 18 feet, above it; 9 to 12 feet on the east side and 5 to 8 feet below; the mass of rip rap which had been placed above and beside the pier having been swept from above and under it, and deposited in a long irregular windrow below.

A bed of the larger stone however was left on the bottom and among the piles, and was apparently safe to resume building upon for the purpose of securing the piles, provided the weight of the pier did not rest on the new filling. The grillage extended about 4 feet beyond the pier, on ends and sides, supported by piles which had never carried weight; on this frame, bents of false work were placed, carrying cross girders, from which the bridge was suspended by screw bolts having eyes fitted to take hold of the end piers. As these pins had but little projection, and part of the eyes bore on the screw thread of the pins, they were filled with hard babbit metal before the lifting strain was placed upon them, the bridge was then hung on this frame pending the removal of the broken pier.

Meantime the coffer dam had been built; this was done by making an irregular framework of five sides, its largest dimensions about 50 × 70 feet, having to enclose in it an old pier which had sunk and remained in the bottom; this was placed around the pier at the water surface and braced to the pier, similar frames of exactly the same size and shape were sunk below it,and the whole covered with 2-inch sheet piling, well nailed on by the diver, who also braced the lower stringers, in all available places, to the piles, etc. A sheet of canvas was now placed outside of the sheet piling with a flap extending from 4 to 6 feet out on the river bottom, the outer edge being covered with clay, in bags, and loose. All the stringers were made of long 3-inch planks from 10 to 13 inches wide, lapping and bolted together. The coffer dam was not made strong enough to empty entirely, it being necessary to draw the water down only about 5 feet to enable the workmen to get at the pile heads.

To empty the coffer-dam a 4-inch pipe line was laid from the nearest street main, giving a pressure at the coffer-dam of about 90 pounds per square inch, an ejector tube was made of four boards nailed together, the boards near the mouth being sawed so as to bend readily, its dimensions were 9 inches at the mouth, 5 inches square 2 feet from the mouth, then enlarging gradually to the discharge end where it was 7 inches square, length 16 feet. At the mouth a common fire nozzle with 1¼-inch ring tip was secured central to the tube, and connected to the pipe line with ordinary 2½-inch hose.

This jet threw a solid 7-inch stream without requiring any attention, thus relieving the work of any dependence upon, or annoyance from, pumps of any description.

The whole deep water portion of the coffer-dam was tight, and remained so during the work, being mostly in mud bottom; the windrow of loose stone below the pier however, gave trouble enough, the water finding its way through first one place and then another, till the bottom of the river had been covered with canvas and clay, for a distance of 50 feet below the coffer-dam

Examination of the substructure showed that the piles had been well driven, and in ample number, but very irregular in position; owing to the débris of the old pier having been very much in the way, the grillage however, had been made as an open framework of 10-inch timber, the cross pieces being about 3½ feet apart, at both ends. These cross pieces rested more or less on the piles, but at, and up-stream from, the center, there were three of them which did not touch any piles, leaving over 10 feet of the pier entirely unsupported. The excellent character of the masonry had proved able to sustain itself in this position till the additional load was placed on it. The piles, owing to the washing away of the rip-rap, were standing unsupported—in some places as much as 12 feet—to knit these together, bags were filled with concrete, lowered to the diver, and by him laid in layers and tramped down, The material used was machine broken stone and cement, no sand being used, this rapidly became solid, in one case the attempt to move a bag laid the day before was a failure, though the diver tried a crow bar, the bags (centals) were filled about two-thirds full, to enable them to be fitted to place easily—between 2,000 and 3,000 were used in this filling. The debris of the old pier was used for new rip rap, the stones were lifted by a winch on a truck running on overhead beams, placed on another truck on a temporary track on the bridge, and taken ashore for storage, the same apparatus returning the material for rebuilding. The pier and broken grillage being removed a new grillage was built on the pile heads instead of between them, this was of cross timbers of 12-inch oak covered with the same, lengthwise of the pier;on taking up the canvas that part of it which had been covered with mud, was found so rotten as to be worthless, it had been buried about six weeks—that which had not been in the mud was quite sound.

Cleansing Feed-Water for Boilers.

An improved process for treating or separating waste or spent lye containing chlorate of magnesium into magnesia and hydro-chloric acid for manufacturing carbon magnesia as material for cleansing feed-water for boilers, for clarifying and decoloring all kinds of fluids, and especially for cleansing all kinds of factory lye and sewage waters, and rendering the same innocuous, has been invented by Messrs. Bohlig and Heyne, of Eisenach. Spent lye containing chlorate of magnesia, such as, for instance, results from the process of crystallizing out the double salt of chlorate of potash and chlorate of magnesia as a worthless subsidary product, is mixed with a fixed amount of wood fillings or saw-dust and placed in damp condition in an air-tight retort and heated successively up to red-glow heat until the gases are driven off or a sample heated with spirit of ammonia will not produce white vapor. They prefer to employ like quantities of wood fillings or saw-dust and chlorate of magnesia lye containing 30 per cent. $MgCl_2$ and intimately mix the same before charging the said mixture into the retort: but they do not confine themselves to this special proportion, as it can be varied without in any way departing from the tenor of the invention. The acid vapors passing of are led into an ordinary Glover and converted into hydrochloric acid.

The perfect separation of the chlorate of magnesia into magnesia and hydrochloric acid at a comparatively low temperature can only then be attained when the quantity or concentration of the lye is so chosen that the resulting carbon-magnesia does not contain much more than 40 per cent. magnesia. On the other hand, if too great heat be applied the well known partial decomposition will ensue. The carbon-magnesia produced according to this process contains magnesia in pure, finely-divided, and consequently most efficiently acting form is when brought into contact with water rapidly converted into a hydrate, and serves as filling or charge for filter cylinders for purifying feed-water for boilers and other purposes. A further appropriate application for the carbon-magnesia is for clarifying and decoloring fluids as a substitute for animal charcoal, and especially for rendering all kinds of waters from industrial establishments innoxious, as the magnesia is the most rational matter for effecting this object, and while the carbon-magnesia as such or after its carbonisation by means of fire gases is the most appropriate form for producing the precipitation of the organic matter or phosphoric acid ammonia in such waters and rendering the same innoxious.

Municipal Engineering; Paper No. 4.*

PHILADELPHIA, PA.

(*Continued from page 400.*)

Geology.—Mica schists and gneisses, apparently of one series, underlie nearly the whole area, with a pitch generally to the northwest. The depth of rock decreases from 100 feet or more in the southern portion to about 50 feet in the center of the city, above which, along the Schuylkill and Wissahickon creek, it is frequently exposed. A large portion of the lower end of the city is of alluvial formation, a narrow strip of which also extends up the Delaware through the city. Flanking this is a belt of Trenton gravel, merging into Philadelphia brick clays, red gravel and yellow gravel, of varying thickness. The upper layer is generally clay in the built-up portion, and beneath it alternate layers of sand and gravel. In the northeastern portion the gravel comes to the surface, while in the northwest, clay lies directly on the gneiss rock, generally less than 6 feet in depth.

Finances.—The revenues of the city are mainly derived from direct taxation of property—real estate, furniture, horses and cattle, and pleasure carriages—the total value of which as returned for the tax assessment of 1885, was $597,785,428. Property is assessed at its marketable value, and the rate of taxation at present is $18.50 per $1,000, except on real estate in rural portions which is taxed at two-thirds the full rate, and "agricultural and farm lands," which are taxed at one-half; this reduced the tax levy of last year by over $400,000, or to $10,645,496.70. The next largest revenue is from the Water Department, the receipts of which for many years have exceeded the expenditures by over $500,000 annually. Department receipts are not used directly for expenses of the same but are turned into the city treasury as soon as received. The expenses of the departments are paid from appropriations made annually by councils in numerous specific items for each. The total funded debt of the city on January 1, 1886, was $62,068,120.22, a decrease of $1,699,321.02 in the year preceding. The means of paying the debt at the same time was $28,314,912.67 chiefly sinking fund securities.

A state law forbids the further increase of the city debt, except for a specific purpose and then only to the extent of one per cent. on the assessed valuation; such a loan, moreover, shall not be authorized until provision shall have been made for the collection of an annual tax sufficient to pay the interest, and also the principal within thirty years. Another guard against increased indebtedness, is a law forbidding the controller to countersign any warrants "until the total of all appropriations, all estimates, and other lawful obligations, shall have been brought within the sum yielded by the tax levy and average income from other sources."

Management of Public Works.

The public works to be considered in this article are managed by the following departments and bodies: Department of Surveys, Highway Department, Water Department, Electrical Department, Trustees of Gas Works and Board of Health, each of which, except the last, was established by acts of legislature and ordinances of city councils and is regulated by the latter (also, in part, the Board of Health). Over the operations of each department councils exercises a general supervision through its committees. The heads of the above named departments (styled respectively Chief Engineer and Surveyor, Chief Commissioner of Highways, Chief Engineer of the Water Department and Chief of Electrical Department) are elected by the two branches of city councils in joint convention, each for a term of three years, except the Chief Engineer and Surveyor whose term is five years. Each appoints, with the approval of Select Council, his own subordinates, removable at his pleasure. Though no civil service rules are in effect in any department here considered, subordinates frequently remain through successive administrations, and sometimes rise from the lowest to the highest positions.

The following is a list of the principle officers in those departments having charge of the works to be hereafter considered, with annual salary and bond, when security is required:

	SALARY.	BONDS.
Chief Engineer and Surveyor	$ 4,000	
*District Surveyors (besides fees)	500	$ 4,000
Chief Commissioner of Highways	4,500	25,000
Chief Engineer of Water Department	7,500	10,000
General Superintendent Water Dept.	3,500	
Registrar of Water Department	3,000	25,000
Chief of Electrical Department	3,000 †	

The head of each department is the chief executive of that branch of the government, and directs all its operations but has no power to undertake any work or make any contract for work or materials not authorized by councils.

The following is the ordinance regarding office hours of the departments: "The head of each and every department of the city of Philadelphia shall see that the various offices of his department are kept open for the transaction of business during such hours as public exigency and convenience may demand: *Provided always*, That said offices shall be kept open continuously from nine o'clock A. M. to three o'clock P. M., every day in the year, Sundays and legal holidays excepted, and during said hours the employés of said departments shall be constantly present and employed."

Each department being governed for the most part by special ordinances applying to no other, no further general description of the management of Public Works can be given. The details, peculiar to each, will be found in the following separate accounts.

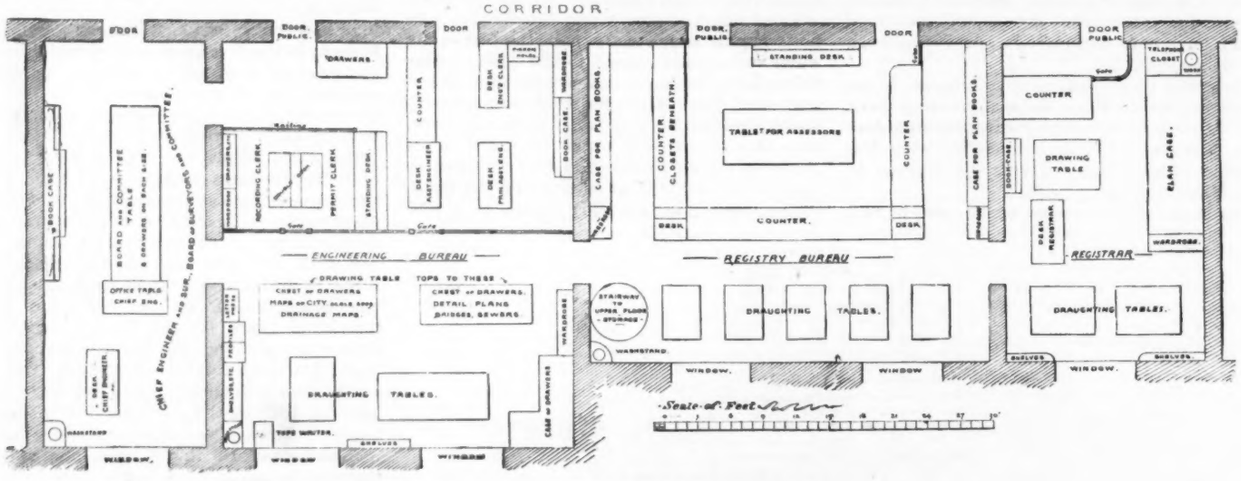


Plate 1.—Arrangement of Office of Chief Engineer and Surveyor.

The principal engineering departments—surveys, highway and water, especially the two former—are interlocked in such an intricate fashion as to puzzle those unfamiliar. The first not only makes all surveys, including the laying out of streets (to be paved and kept in repair by the Highway Department,) but constructs all sewers and bridges, afterward to be kept in repair by the Highway Department.

Survey Department.

The Department of Surveys is in itself the most complicated of the three. It may be considered in three parts: Office of the Chief Engineer and Surveyor (who is at the head of the whole Department); the District Surveyors (who, with the Chief Engineer and Surveyor as president, constitute the Board of Surveyors); and the Registry Bureau.

Office of the Chief Engineer and Surveyor.

The Chief Engineer and Surveyor is elected for a term of five years by the Select and Common Councils in joint session. He "shall be a citizen who shall have had five years practical experience as a civil engineer." He receives a salary of $4,000 a year; his principal assistant engineer, $2,000; assistant engineer (in immediate charge of sewer construction), $1,800; recording clerk, $1,500; draughtsman; $1,500; sewer registrar, $1,500; two draughtsmen, $1,000 each; two clerks, $900 each; stenographer and type writer, $600; rodman, $720.

The District Surveyors (thirteen in number), are elected directly by the people every five years. They have separate offices in their respective districts. Each receives a yearly salary of $500 "for keeping and furnishing the public record of surveys and performing his duties as a member of said board (of sur-

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* Elected by the people.

† Provided he gives his undivided attention to the duties of the office.

vevors)," in addition to the fees and charges allowed in the following ordinance:

The district surveyors shall be allowed to charge and demand, in advance, the following, from the owners of property ordering the work to be performed or against whom the same is properly chargeable, viz.: For surveying and regulating each lot of not more than 20 feet in width, $3; each lot of more than 20 feet, and not over 40 feet in width, $4; each lot of 40 feet and not over 60 feet, in width $5; each lot of more than 60feet and not over 100 feet in width, $6; and for each additional foot in width, two cents. For measuring and making returns of paving and curbing, two cents per linear foot of property on each side, payable by contractor. For furnishing heights and stakes for resetting curb, 75 feet continuously or under, $1.50. For each additional foot, two cents. For measuring and making returns of repaving and paving new intersections, two cents per square yard to be paid by contractor. And they shall be entitled to demand and receive from the city corporation the following, viz.: For measuring, making drawings and returns for water-pipes, two cents per linear foot of property on each side, inclusive of description for liens for pipe laid. For gutter or grading stakes, one cent per linear foot. For furnishing heights and stakes, 100 feet or less, of new curbing $2.50; and two cents per foot for each additional foot. For preparing liens for municipal claims each (exclusive of water pipe liens), $1. For surveys and and duplicate sectional plans for line regulation, per acre, $2. For surveys and duplicate sectional plans for grade regulations per acre, $1.50. For duplicate sectional plans, comprising both line and grade regulations, per acre $3. For superintendence of branch culverts (sewers) with lines and levels, property plans and assessment bills, with certificate that specifications have been complied with, per linear foot, six cents, payable by contractor."

Their duties as surveyors, as indicated in the above paragraph, are partially defined in the following selections from ordinances.

"The said district surveyors shall, in their respective districts, lay out and survey the same, as may be required from time to time, and shall designate the proper lines, levels, and grades, as established by the confirmed plan of such district as he may have in charge."

Each district surveyor shall keep an accurate record, in a book provided by the city for that purpose, of all surveys and adjustments of party lines and shall also furnish duplicates thereof, to the chief engineer and surveyor within one month after the same is made, and also such plans of such parts of said district and in such form and with such details as said chief engineer shall from time to time require for official purposes; and all plans, surveys, records, minutes, notes, memoranda and regulations, whether in the principal office or in in the respective offices of the district surveyors, shall be the property of the city of Philadelphia, and shall be delivered up to their successors in office on the termination of their official service." "The district surveyors and regulators shall be required to attend to all surveys to be made with a view to the erection of new buildings, or other work in their respective districts, within four working days after notice to do so."

As members of the Board of Surveyors they are "invested with full authority to examine and finally confirm or reject all plans of surveys or revisions of plans of the city;" and "all general plans for sewers, bridges or other improvements to be constructed under the direction of the chief engineer and surveyor, shall be approved by the board."

The Registry Bureau.

"The object of the registry bureau is indicated by the following act:

The chief engineer and surveyor of the city of Philadelphia, under an ordinance and appropriation by the councils thereof, shall cause to be made books of plans of the said city, divided into sections, so far as the streets of the said city are or shall be laid out, which shall show the situation and dimensions of each property therein, with the city numbers thereof, and who are the owners, with such succession of blank columns as will permit the names of future owners to be entered therein, with the dates of transfer, and with index for recording such names alphabetically, and the person or persons who shall be employed to perform such duty, shall have access to all plans of survey in the offices of any surveyor of the said city, to all books in the recorder of deeds' office, and all records of the courts, and in the registers office, and may take copies or extracts thereof without any charge therefore."

This department is especially interesting as being (it is claimed) the first and probably the most perfect example of this system of property registration in any city in the country.

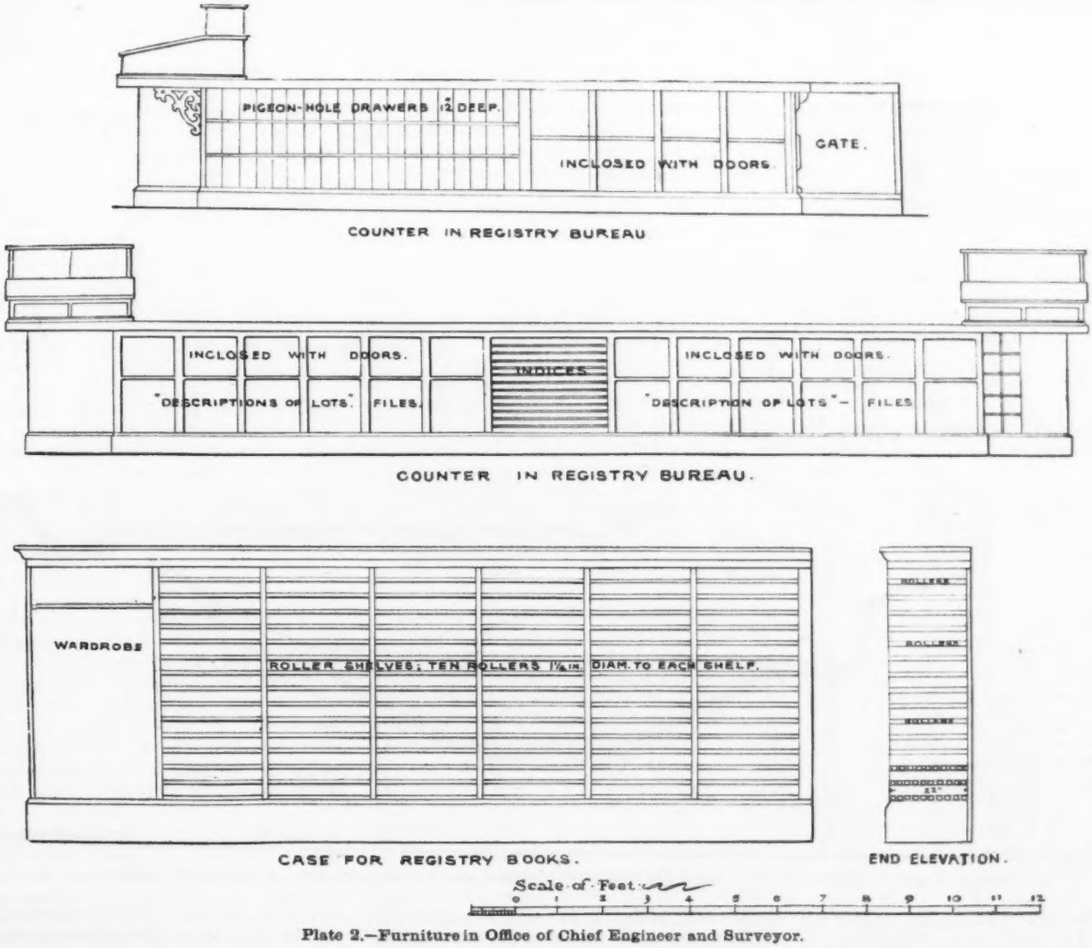

PIGEON-HOLE DRAWERS 12 DEEP.
INCLOSED WITH DOORS.
GATE.
COUNTER IN REGISTRY BUREAU
INCLOSED WITH DOORS.
INDICES.
INCLOSED WITH DOORS.
"DESCRIPTIONS OF LOTS." FILES.
"DESCRIPTION OF LOTS" — FILES
COUNTER IN REGISTRY BUREAU.
WARDROBE
ROLLER SHELVES; TEN ROLLERS 1¾ IN. DIAM. TO EACH SHELF.
CASE FOR REGISTRY BOOKS.
END ELEVATION.
Scale of Feet
0 1 2 3 4 5 6 7 8 9 10 11 12

Plate 2.—Furniture in Office of Chief Engineer and Surveyor.

The office is in immediate charge of a registrar, appointed by the Chief Engineer and Surveyor (by and with the advice and consent of select council) who receives a salary of $1,500 a year and has the assistance of several clerks and draughtsmen.

Following is an abstract of some of the acts regulating the registry service:

The duty of registering real estate devolves "upon the purchaser, devisee by will, the person to whom an allotment in partition shall have been made, or their agent, and they shall be required to present their deeds or title papers at the registry bureau so that the same may be endorsed," under penalty of five dollars; the sheriff "shall present the deeds of all property that may be sold at judicial sales," and the recorder of deeds is directed to refuse to admit any deed to record until the same is properly registered, under penalty of five dollars and indictment for misdemeanor in office. If the Chief Engineer and Surveyor apprehend that conveyances have been made without being reported to him, he shall cause search to be made therefor, and in cases where descriptions of properties in deeds presented for record do not designate their location so that they may be placed upon the plan books, he is authorized to direct a survey to be made thereof.

(In a later issue we may present, in a separate article, a more detailed account of the methods employed in the Registry Bureau).

The accompanying plans (Plates 1 and 2) show the arrangement of rooms in the public buildings at present occupied by the Department of Surveys, with elevations of some of the furniture.

NOTE.—The map given last week shows a general plan of the city only; the smaller streets and alley-ways are entirely omitted and only a part of West Philadelphia is shown. The new Penrose Ferry bridge and the South Side extension of the Baltimore & Ohio R. R., with its bridge, near the Gray's Ferry bridge, have also been constructed since this map was made.

ED. ENG. NEWS.

TO BE CONTINUED.

The Gileppe Dam, Near Verviers, Belgium.

BY GAETANO GRUGNOLA*

TRANSLATED FOR ENGINEERING NEWS, BY GUISEPPE BONANNO.

Civil Engineer and Architect, graduate of the University of Palermo, Italy.

From the earliest period of our world's history water has been an element of the utmost importance to man, and hydraulic construction developed rapidly and formed the chief branch of engineering in the early records of our race. With the advance in civilization water became an absolute necessity, and on every hand agriculture, commerce, trade and the public convenience demanded an extension of the supply.

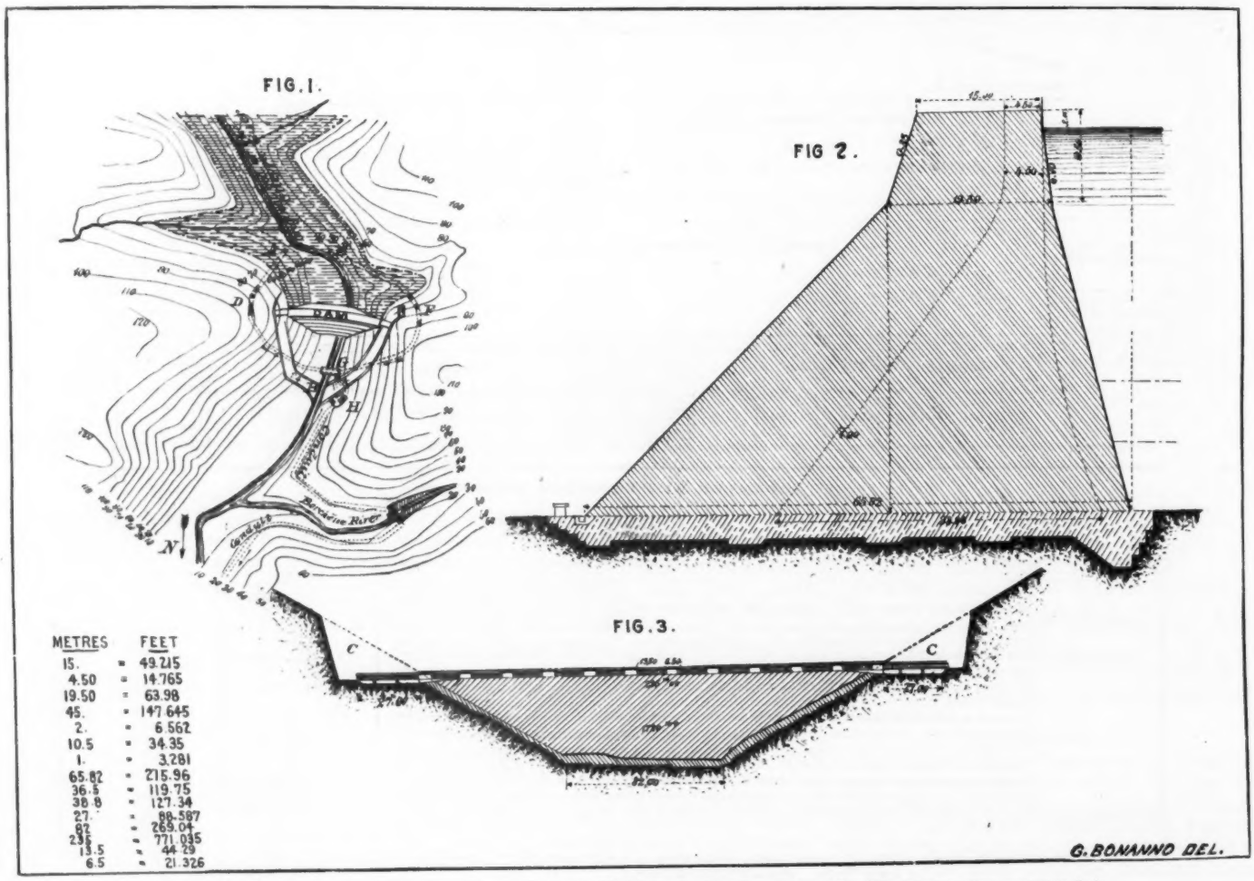
We see this striving after greater volumes of the precious fluid in the extensive reservoirs of India, the chief factor in the development of that nation, and in the aqueducts of ancient Rome which even in their ruins bear witness to the magnitude and grandeur of their original conception and execution. In Spain, too, important old aqueducts and dams still exist, but the theory upon which the proper construction of reservoirs is based dates only from the nineteenth century.

This construction has now been reduced to an exact science, with a resulting greater security and economy in material, the latter amounting to as much as from one-third to one-half when compared with the sections of centuries ago. It is now recognized that it is not so much a question of mass as it is the proper distribution of this mass in counteracting hydraulic pressures and maintaining the equilibrium of a structure of this character.

In the following paper it is proposed to demonstrate this principal and illustrate it by a description of the Gileppe dam, one of the most important of the dams of Europe, and built by the state of Belgium in 1869-75.

The dam of Gileppe is designed to impound the water of the Gileppe river and provide a reservoir from which water could be supplied to the city of Verviers, about 6.2 miles distant. This Verviers is a small city near the frontier of Prussia and has a population of about 38,000, chiefly employed in the manufacture of cloth and cotton goods. As this trade was considerable and rapidly extending, the then supply of water was deemed totally inadequate, and it was determined to seek in the neighborhood for some means of increase.

Bidant, the chief engineer of the proposed works, presented plans in 1857 and 1859; but as the neighboring city of Eupen desired to participate in the advantages to be derived he was later obliged to make further studies upon a broader basis of supply. These new plans were completed in 1860 and 1863. He proposed a large storage basin in the Vesdre valley; but as the outlay involved was enormous, and the citizens of Eupen objected, both on this score and because some of them became alarmed at the possible fatal consequences to them of a break in the dam, this scheme was abandoned. The city of Verviers then decided to construct a great reservoir on its individual account and



The Gileppe Dam; Verviers, Belgium.—NOTE: *The vertical height omitted on the cross-section Fig. 2 is 45 metres, or 147.64 feet.*

*Gaetano Grugnola is a civil engineer of high repute in Italy and other continental countries; he is a profound mathematician and the author of works upon hydraulic construction and graphic statics. Among his chief works are:—"*Sulla spinta delle terre e delle masse liquide,*" (Upon the pressure of solid and liquid bodies). "*Metodi grafici per calcolare i movimenti di terra,*" (Graphic method of calculating the movement of soil), and "*Dei tetti metallici, applicatione dei metodi grafici allo studio della stabilitita delle incavallature,*" (Upon metallic roofs, application of the graphic to the determination of the stability of roof trusses).

the subject was again investigated upon this latter basis.

This study continued through two years. It was first estimated that 14,600,000 cubic. metres (3,856,000,000 U. S. gallons) would be required annually, but this quantity was afterwards raised to 17,000,000 cubic metres (5,491,000,000 gallons). Of the tributaries of the Vesdre river the Gileppe was found to be best situated for impounding purposes. The rainfall of 1864, the driest year since 1833, was taken as a basis, the flow was measured, and taking into due consideration the evaporation, percolation, etc., it was found that the quantity of water at command was equal to 23,202,840 cubic metres(6,130,190,328 U. S. gallons) from September 1,1864 to September 1, 1865.

Upon the basis of there investigations the capacity of the proposed reservoir was fixed at 12,000,000 cubic metres (3,170,400,000 U.S. gallons). The local conditions in the valley of the Gileppe were excellent. Theoretically the site of a reservoir should have an impermeable bottom with at least five feet of clay, which would be increased by later sedimentary deposits; the valley should have as small a cross-section as possible at the site of the dam; the bottom of the basin should slope away gradually from the dam so that the maximum volume of water may be enclosed, and the dam itself should rest upon a tight and incompressible stratum, with a quarry in its immediate neighborhood from which suitable material can be obtained for construction. All of these conditions were present in the valley of the Gileppe.

The next subject investigated was to determine whether one basin of 12,000,000 cubic metres capacity or several of smaller dimensions were most advisable. This choice depends greatly upon the topography of the main basin; but while equal amounts of water might be impounded by several lower dams the danger of rupture is multiplied and it is very possible that the breaking of a high-level dam would sweep away the lower dams exposed to this sudden outrush of water.

In this case one dam was decided upon by Engineer Bidant, as it was found on investigation than one dam 45 metres (147.6 ft.) high would store the quantity of water required more economically than four dams, 29 metres (95.12 ft.) high each. In support of his proposition to the state authorities Bidant referred to the dam of Alicante, in Spain, which was 41 metres (134.48 ft.) high and the Furens dam of France, which was then (1864) in process of construction and was to be 50 metres, or 164 feet high.

The site selected for the dam was a point about one mile from the junction of the Gileppe with the Vesdre river. The valley there contracted to a ravine only 1,968 feet wide, but widened out again immediately below. This site offered another and great advantage in the fact that the stratification of the confining hills conformed with the surface contour of these hills; there was in fact no outcrop of the rock into the valley, and consequently little chance for filtration around the dam through the rock strata. The section across the valley was also regular, without projections, another feature of importance in this class of construction.

As already mentioned the dam was to be 45 metres high, the area of water surface in the reservoir was 800,500 square metres and the capacity estimated at 12,238,916 cubic metres. But to prevent waves developed on such an extent of water surface from dashing over the dam, this structure had to be raised some certain elevation above the highest dead-water level. This dimension is dependent upon the area of the basin, its depth and width and certain other considerations necessary for the stability of the structure. Bidant fixed this superelevation, as we may call it, at 2 metres (6.56 ft.), which seems to us very low. Engineer Krantz, in his "*Etudes sur les murs des reservoirs*," gives for a dam 45 metres high a superelevation of 3.50 metres (11.48 ft.); and in the reservoirs of Chazilly and Cercy, with smaller areas than Gileppe, Minard* observed waves that had a height of 3 metres (9.84 ft.) It may be remarked, however, that special cases based upon local disturbances cannot well be utilized in formulating a law; wave-formation is a complicated phenomenon and it is difficult to establish the true relation between cause and effect and establish *a priori* the possible wave-height in any given case.

The bottom of the valley of Gileppe lies at an elevation of 241 metres (790 feet) above the sea, and has a general direction as shown in Fig. 1. The largest possible waves therefore will break against the sides of the reservoir. This arrangement explains in part the low elevation given by Bidant to the dam. But it is pertinent to enquire how the waters of the Hocque and Eupen rivers, which flow into the Gileppe and sometimes add 2 metres in height to the calculated high water mark, can do so without overflowing the top of the dam and producing a cascade which may be dangerous to the masonry?

Static conditions alone cannot determine the width of the dam at the top. Mathematically this width would approximate zero, as at that point the pressure resulting from the weight of the water is a minimum: but there are other and important considerations, such as the depth of water, the direction of prevailing winds, the formation of ice floes and especially the shock of waves. The ice action depends upon the latitude of the basin, quiet water in formation and the movement by winds of the ice-fields when broken up. Bidant settled upon 15 metres (49.2 feet) as the thickness of his dam at the top; in this taking a mean between the Alicante dam, which is 19.70 metres, and the Furens dam, which is 5.70 metres, wide at top. At this time (1869-75) the first named was 300 years old, and the latter in course of construction.

The base of the Gileppe dam was made 65.82 metres (215.96 feet) and the result was the extraordinary cross-section shown in Fig. 2. Bidant in figuring out this thickness (which is justified neither by theory or special conditions) could not possibly have properly studied the section of the dams which he took as his models, viz: the dam of Alicante, which has a base of only 32.50 metres (106.6 feet) and that of Furens with a base of 49.00 metres (160.98 feet).

The following table gives a comparative exhibit of the principal dimensions of the three dams in question and also the application of the Furens type to a dam at the site of the Gileppe dam:

Names of the Dams.	Date of construction.	Thickness. at the top.	Thickness. at the bottom.	Height of water level.	Volume of Dam per linear metre.*	Max. Pressure Supported by Masonry.
		mets	mets	mets	Cub. mets.	Kilogs per sq. c-m.
Alincate....	1579-1584	19.80	32.50	38.75	1100.00	11.30
Furens.....	1862-1866	5.70	49.08	50.00	995.30	6.67
Gileppe	1869-1875	15.70	65.82	45.00	1738.22	6.00
Type proposed by G. Grugnola—Furens dam for a height of 45 metres.	.....	4.50	38.88	45.00	781.42	7.00
	.....	5.70	39.70	45.00	768.43	5.39

* Section taken at right angles to the face of the dam.

From this table it will seen that the Gileppe dam has a mass about twice as great as necessary, and that without its stability being increased. This is all the more astonishing when we consider that Bidant was familiar with the profile of the Furens dam and could have enlarged this, if he thought it necessary, without exaggerating it. Fig. 2 shows the proposed correct profile superimposed upon the actual cross-section as built, and graphically illustrates the disproportion.

Bidant endeavors to justify the enormous dimensions given to the Gileppe dam by the following considerations:

1. The capacity of the reservoir exceeding 12,000,000 cubic metres, or 10,000,000 more than the Furens basin, the consequence in case of rupture would have been more serious than from a break in the latter.

2. The length of the dam is 235 metres (768.8 ft.) at the top, which is 135 metres more than the Furens; and Bidant thinks that the proportion of dams should increase with their volume.

3. As the Gileppe dam was the first built in Belgium, he thought it absolutely essential that it should not fail, so that the people should be more favorably disposed towards similar future construction.

4. The dam had to resist the possible floods from the Hocque and Eupen rivers.

To these reasons given the following reply may be made: In the first place, the increase in the volume of water does not influence the pressure exerted by this water against the interior face of the dam, provided the depth remains unchanged. For example, the Habra dam had a capacity of 30,000,000 cubic metres, which is much greater than any of the first named dams. The profile of this dam was correct, and its failure must be ascribed to other causes.

Secondly:—The pressure on the dam has nothing to do with its length, but is entirely dependent upon the vertical section taken perpendicular to the faces of the dam. The joining of the vertical section to the rest of the dam and its abutments only increases the stability. The Habra dam was 325 metres (1,076 ft.) long, or longer than the Gileppe, without considering the waste-weirs at either end which would add 120 metres (393.6 ft.) to the length. This reasoning of Bidant was approved by many engineers of the early part of this century who looked upon a dam as a beam supported at the ends and uniformly loaded. But this idea cannot now be accepted because the cohesion of the mortar does not equal that of the stone and the dead weight of the dam is comparatively too great. Minard, in his work before quoted, written (1841) before the building of the Gileppe dam, strongly opposed this old theory, and it is therefore all the more surprising that Bidant should still have adhered to it.

Thirdly:—A profile with smaller dimensions more in conformity with theory would have produced the same effect as that demanded.

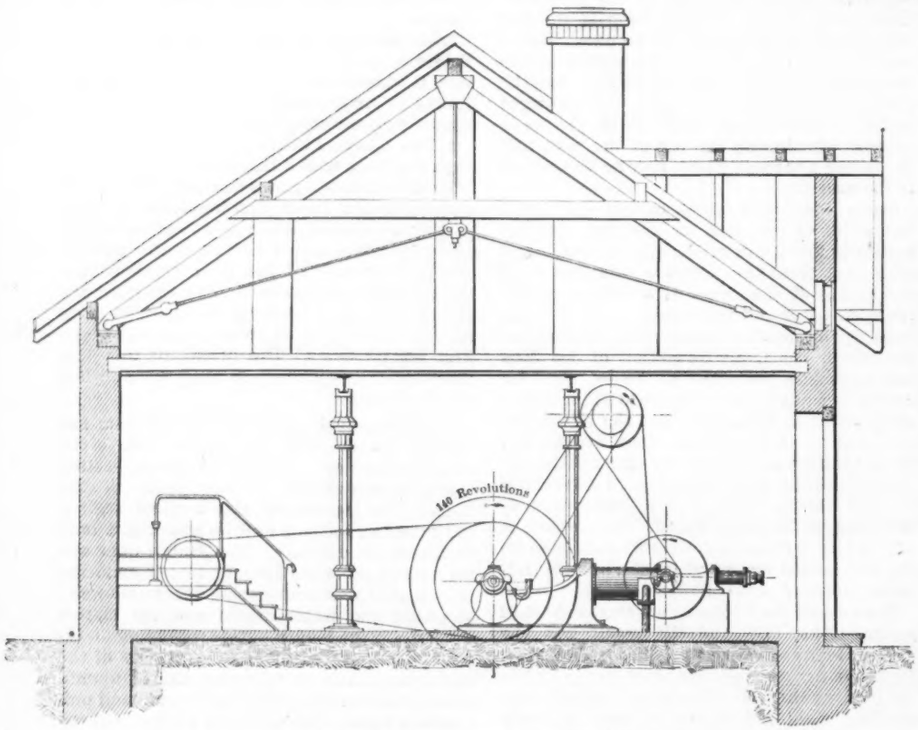
Fourthly:—The dam did not require so great a section above the normal water-line. The great length of the dam would easily have disposed of all the water resulting from floods in the two rivers without any dangerous effect.

Enormous thickness of masonry is not a guarantee of the stability of a dam. The action of the forces applied to this class of construction is perfectly understood, and equilibrium in the mass can be secured in accordance with known laws. The chief difficulty lies in the detail of construction and the execution of the masonry; in this direction the greatest possible care must be taken, for the least negligence may prove fatal.

The principal condition is that the dam

*Minard:—"*Cours de construction des ouvrages qui établissant la navigation des rivieres et des canaux*," 841, Cap. XXV., p. 322.

should be impermeable to water. Absolute tightness is not always attainable at first, and the result obtained at the Furens, where the leakage on the exterior face was very small, may be called exceptional. When water was first turned against the dams of Lampy, Gros-bois, Chazilly and Vioreau, very considerable and alarming percolation was noted on their exterior faces; but in the course of time this diminished and finally disappeared. This leakage was observable especially at one-third of the height from the bottom. In the Lampy dam the experiment was tried of throwing into the reservoir several hundred cubic metres of quicklime, which materially assisted in making it water-tight. In the Habra dam the leaks were very numerous and contributed very much towards the weakening of the dam. The penetration of water



Gas-Engine Plant at Prague: Elevation.

into the interior of the masonry has a very important effect, and from the conditions of the case very great and destructive hydrostatic action may be exerted. In fact this, in the majority of cases, is the chief cause of rupture in dams.

As showing that mass alone has little effect; it might be remarked that in the Gileppe dam there were many leaks on the exterior face; a fact that led to the belief that the inside masonry was not well executed. A precautionary measure against this leakage is to coat the interior face of the dam with asphalte. The foundations, too, should be laid deep in order that water may not find its way under the dam, Fig. 2 shows the concrete foundation of the Gileppe dam to have been 7.40 metres (34.27 ft.) deep.

As shown in Fig. 1, the Gileppe dam was located on an arc of a circle with a radius of 500 metres (1,640 ft.), with the extrados of the arch facing the reservoir, and the side-hills supplying the skewbacks. This is a form affording the greatest security, when we consider the elasticity of masonry (now an indisputable fact) and the properties of an arch in transferring the water-pressure to the abutments, assuming that the cohesion of the hydraulic cement is perfect. But it is also well to observe that the stress transmitted from the dam to the skewbacks is that due to water pressure only, for the weight of the masonry acting vertically, can not be so transferred. This fact largely reduces the advantages resulting from a curved form; though from practical considerations it is better to give it this form whenever the topography of the site will permit. In calculation, however, the curves should be entirely ignored, as greater stability will thus result; unless it is a case requiring a very high dam and great economy of material.

Fig. 3 gives a longitudinal section of the dam with its principal dimensions, At the bottom of the valley the length is 82 metres (268.96 ft.) and at the top it is 235 metres (770.8 ft). The maximum transverse section contains (Fig. 2) 1738 square metres (18,701.5 sq. ft.); the total quantity of masonry is 248,470 cubic metres (323,011 cu. yds.) and the weight is 571,481,000 kilograms (562,337.3 tons.)

The maximum water-level is 45 metres, and to preserve this, waste-weirs are built at each end of the dam at *C, C*, Fig. 3; these weirs are each 27 metres (88.56 ft.) long, and are excavated from the solid rock. They connect with two canals converging at *B*, Fig. 1, and through these open conduits the surplus water is conducted to the original river of Gileppe.

As the dam serves as a means of communication between the two sides of the valley, two iron bridges, of 9 metres span each, connect the dam with the lateral roads. Water is taken from the basin by two tunnels *A B G*, and *E F G*, Fig. 1, driven in the sides of the hill some distance back from the dam, similar somewhat to the arrangement at the Furens There was thus no break in the masonry of the dam. In this connection Chief Engineer Graeff, in his "Rapport sur la forme et le mode de construction des barrage du Gouffre d'Enfer sur le Furens et des grands barrage en general," says—"We would have regarded as a permanent danger any opening in a dam as high as that of Furens."

The two tunnels of Gileppe pierce the mountains about 100 metres (328 feet) above the dam; two being built so that one could always be in service during repairs on the other. These tunnels are 2.70 metres (8.856feet) high and 2.40 metres (7.872feet) wide; they are lined with masonry and tap the reservoir at the points *A* and *E* where they terminate in iron gratings; they are arranged to drain the lowest level of the valley. These tunnels were constructed between April 1867 and may 1869 and served to pass the waters of the Gileppe while the dam—finished in 1869—was being built. The maxium flow was 20 cubic metres, or 5,283.6 U. S. gallons per second.

The pipes for supplying the city of Verviers were laid in these tunnels and connect with the gate-house H from which the water is destributed by a tunnel. This tunnel is 2 metres (9.56feet.) and lined with masonry, with vertical sides and an arched roof 2.50 metres (8.2feet) high. It follows the left bank of the Gileppe and Vesdre rivers to the city, a distance of 5.6 miles. Near Verviers a reservoir was constructed 85 metres (278.3feet) above the mean level of the city, into which the tunnel empties; from the reservoir the water is distributed to various points by four cast-iron 24-inch mains. The cement mortar used in building the dam was made of five parts of hydraulic lime from Tournay, four parts sand and one part of *Trass del Reno* (a kind of pozzuolana)

On the center of the cornice of the dam a seated lion was placed, executed in stone. As might be expected, the proportions of this lion are gigantic in order to harmonize with the great mass of masonry which it surmounts. The granite base upon which it rests is 26 feet high; the lion is 43.3 feet high and 52.5 long; the mouth is 8 feet wide and the diameter of the tail is 39 inches. Its weight is about 600,000 pounds and it cost $16,000.

As previously mentioned the tunnels were completed in May 1869 and lined with masonry in 1871. The masonry in the dam was commenced July 21, 1870, and was pushed with such vigor that by October. 22 of the same year the structure rose 40 feet above the valley. In 1871, with a force ranging from 80 to 100 laborers. 80,000 cubic yards of masonry were placed in positions and at the close of 1872, 224,718 cubic yards had been built. In November, 1875, all the masonry was finished with a total of. 323,011 cubic yards.

The reservoir was put into service previous to the date last given, the temporary channels having been closed on May 9, 1875, in the presence of some two hundred of the engineers of Belgium and the reservoir commenced to fill from that date.

The arrangement of the work-yards was interesting; the stone for construction having been taken from a point near the intersection of the Gileppe and Vesdre rivers by a narrow tram-way. Another tram was laid between the station at Dolhain (where the Tournay lime and Andernach "trass" were delivered) and the site of the dam. The lime was ground at the works by machinery, and the cement was also prepared there. Three inclined planes were used in delivering the material on to the work proper.

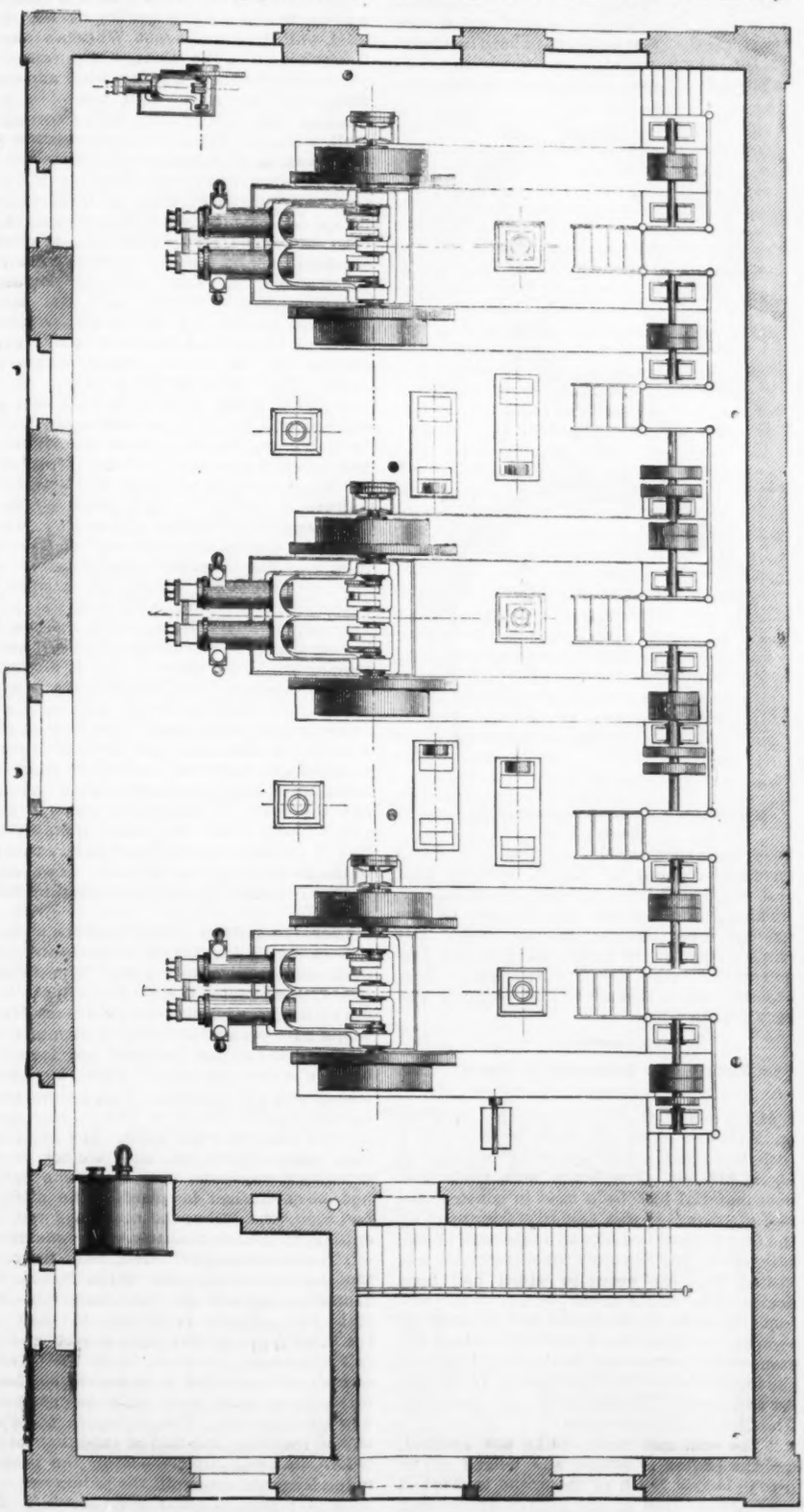
The cost of construction was charged to the state of Belgium and amounted to 4,549,000 francs ($909,000); the masonry consequently cost 18.30 francs per cubic metre ($2.81½ per cubic yard) including all incidental work on the reservoir basin.

The impounded water cost 0.37*f.* per cubic metre, or about $28.00 for each million gallons stored. But while the reservoir had a capacity of only 12,238,916 cubic metres, the actual annual supply taken from it was 17,000,000 cubic metres. Upon this latter basis the price per cubic metre would be 0.27 francs, or $20.40 per million gallons used.

The Otto Gas-Engine Plant at Prague, Austria.

Gas-fuel, as obtained from natural sources or manufactured by the cheap processes of the day, is already recognized as a potent factor in advancing our industrial interests, and as being a convenient and economical means of providing power. In this connection the plant illustrated is interesting.

Isolated electric light plant driven by gas-engines are already popular and in quite common use. But the employment of this type of engine for a motor at central stations from which light is to be distributed is a novelty.



Gas-Engine Plant at Prague: Plan.

The Otto gas-engine was about the first of its class to be introduced into this country and is too well known to need further description than to say that it is a horizontal, fly-wheel engine in which the motive power is supplied by the pressure resulting from the combustion of a mixture of common coal-gas and air, this mixture being compressed to about twelve atmospheres at the moment of ignition.

The plan and elevation illustrated, show the arrangement of these engines at the electric light station in the city of Prague, Austria, as recently erected; its chief interest lies in the extent of the plant of this character employed. The three engines are fifty horse-power each, arranged as shown, and from this station over two hundred arc lights are distributed. In Prague, gas is supplied to the engines at about the actual cost of production, and under these conditions its use in connection with the gas-engine has been found more economical than coal-fuel.

In Koenigsberg and Coblentz gas-engines are employed for pumping water at the water-works; and in smaller towns, such as Duren and Quedlinberg, in Germany, and Wallingford and Stratford-on-Avon, in England, large gas-engines are economically used for industrial purposes.

The question of cheaper rates for gas, a price somewhat nearer the cost of production, has been the only obstacle, heretofore, to the use of larger engines in the United States. But as this difficulty is being solved by the introduction of cheaper processes and consequent vigorous competition, prices are falling and the manufacturers of the engines described are already making extensive preparations for supplying machines far exceeding in power any now in use in this country.

Theories of the Tides.*

BY A. DE PREAUDEAU.

Newton, in his theory of the tides, adopted the inexact hypothesis that the waters of the globe assumed, at each instant, the position of equilibrium due to the forces acting on them; whilst Laplace considered that the moving water, owing to its acquired velocity, passed the position of equilibrium, and made oscillations whose period was proportional to the disturbing forces. Laplace, however, like Newton, based his calculations on the assumption of a globe entirely covered with water, which therefore do not manifest the working of the phenomenon. Assuming therefore a spherical globe, with the vertical passing through its centre in the ordinary conditions of equilibrium, and neglecting the density of the water as compared with that of the earth, then the infinitesimal divergences of the vertical under the attraction of the heavenly which bodies, are the primary causes of the will depend tides, solely on these attractions.

According to Mr. Keller, the tidal currents are the result of transmitted differences of pressure, caused in the first instance by variations in the force of gravity due to the influence of the moon on the particles of water, owing to the difference between their distance from the moon and that of the centre of the earth. Mr. Hatt, on the contary, in his work "Notions sur le Phénomène des Marees," of which this article is mainly a summary, considers that the tide is due essentially to a change in the direction of the vertical, and not to the inappreciable alteration of the force of gravity. The attraction of the moon averages one twelve-millionth that of gravity, and that of the sun is a half less; whereas, when the declination of the moon is zero, it can deviate the vertical near the equator about a third. The first theory is very suitable for affording an elementary idea of the phenomenon; whilst the second conceives the tide as the result of currents produced by the deviation from the

* Abstracts: Inst. Civil Engineers.

vertical under the attraction of the heavenly bodies, and the variations in height as the consequence of the conflict of the currents and of their changes. The movements must evidently be oscillatory, and the vertical displacements generally very feeble compared to the horizontal ones; and the semi-diurnal forces produce motions of the same period along the equatorial zone, but, owing to the inequality of the solar and lunar periods, the lunar tide is stronger than the relative attractions of the two bodies would indicate. The oscillatory motion is considerably modified in limited seas, so that the relation and relative situations of the solar and lunar waves may be greatly changed, which explains in principle the retardation, or age, of the tide observed on the western coasts of Eruope. A general formula for the tides on these coasts is—

$$y = b_0 + b_1 \cos(x - a_1) + b_2 \cos(2x - a_2) + b_4 \cos(4x - a_4) + b_6 \cos(6x - a_6)$$

where y is the rise of tide, x the horary angle of the imaginary heavenly body producing the tide, and $b_0\ b_1\ b_2, a_1, a_2$, coefficients to be determined by observation, the number of terms being larger in proportion as the port is further inland. Local observations only indicate the results of the attractions of the heavenly bodies and of the littoral disturbances; so that it is important to study the influences of the former in order to appreciate properly the effects of the latter.

Economical Tunnel Construction.

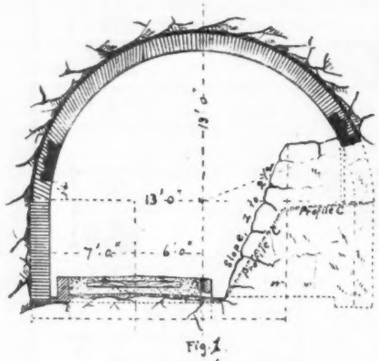
M. Siegler, civil engineer, recently described in the *Annales des Ponts et Chaussées* an economical mode of constructing tunnels for a single track railroad which is subsequently to have a second track laid. The tunnel instanced is the Midrevaux tunnel, on the line of the Gondrecourt & Neufchateau R. R., of which M. Siegler is chief engineer; it is 2,349 feet in length and is on a tangent; the material consists of limestone, damp and split by frost, with boulders of great hardness.

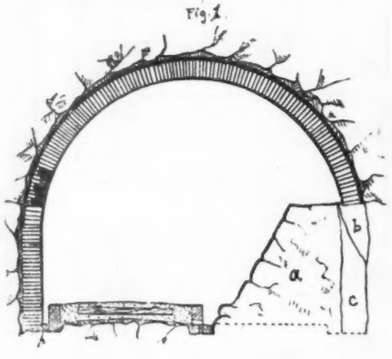
In order to reduce the subsequent cost for the second track as much as possible, M. Siegler decided to construct the arch of sufficient dimensions for a double track but only to build one of the side walls, leaving the other side with the arch resting on the rock. When the construction of the second track was undertaken it was only necessary to remove the side rock and complete the tunnel to the desired section.

The arch was stopped at a height of 5 feet above the level of the springing line, bearing on solid rock, the outward face of which was cut to a slope of 1 : 2½. In consequence of the nature of the material it was necessary in construction to modify this profile for a considerable length and to carry the arch down as far as the springing line, as shown at *C C*, Fig. 1. The enlargement was made in 1885. The rock on which the arch rested was blasted with powder to remove the main portion, *a*, Fig. 2; the work being done in sections 13 feet long. The rock under the lower face of the arch, *b*, Fig. 2, was removed by hand sufficiently to allow of a timber sill being put in; when the arch had been shored up, dynamite was used to remove the part marked *c*, Fig. 2, and the work was completed by hand. The blasting did not cause any injury to the track nor to the original masonry.

The union of the old and the new courses presented some difficulty; the lowest course of the arch, resting directly on the rock without any sill, had not been made to a regular level but followed the irregularities of the rock, so that it became necessary to destroy a part of it in order to make a proper connection between the old and new masonry.

With regard to cost, the first cost of the tunnel was $138,322, the enlargement cost $23,280, making the total expense $161,602. A double track tunnel would have cost $160,826; and two parallel single track tunnels would have cost $114,072 each, or a total of $225,144. In making the tunnel complete for double track, the first cost would have been increased $22,504, which would have brought the total to $160,826. If two single track tunnels had





Midrevaux Tunnel.—Gondrecourt & Neufchateau R. R.

been made successively the first cost would have been reduced by $24,250, but the final cost would have been increased by $66,542.

Taking into account the interest on the amount saved during the six years that elapsed between the construction of the first and second tracks, it was proved that the final economy due to this method of working was very considerable.

The Failure of a Reservoir at Cleveland, O.

At Cleveland, O., the high service reservoir on Kinsman street was built by the city a little more than a year ago at an expense of about $132,000. Complaints were made that poor material had been used in construction and a committee was recently appointed by the City Council to make an inspection of the reservoirs. The Kinsman street reservoir was visited first, the water in which had been drawn off to within about two feet of the bottom; the sides of the banks had slid down as soon as the water was drawn off, crushing the stone at the bottom and leaving large gaps at the top; the south bank had opened in the center and much of it had fallen into the basin. The Cleveland *Leader* says:

"The west and south banks are cracked, and the paving is settled and bulged out in many places. Much of the stone is crushed into shale. One of the pillars underneath the bridge which extends over the reservoir has sunk 2 feet away from the bridge, and the bridge itself has moved out of its original position. A great deal of the stone at the bottom of the basin had crumbled into pieces. Councilman Herron experimented on the stones by running his cane through them as easily as though they were soft clay. In places the walls were bulged out, and the stone heaped up to the height of several feet. Councilman Reader asserted that the condition of the basin was due to the inferior quality of the stone used, while Superintendent Whitelaw was of the opinion that the damage was caused by the sudden drawing off of the water and he affirmed that the stone used was of a good quality. Mr. Reader says that Freeman & Hall, when the contract for the reservoir was first awarded them, agreed with him for stone from his quarry at 95 cents but that they subsequently purchased stone at seventy cents. At the time Mr. Reader took specimens of the cheaper stone to Mr. Whitelaw, protesting against its use on account of its softness and brittleness. The stone was also shown to prominent city architects, and Mr. Reader says that he told Superintendent Whitelaw that a reservoir lined with such stone would cost the city $30,000 for repairs within five years. The fact remains, however, be the cause what it may, that the stone is soft and crushed and the bank is settled and broken open all along the top. After the committee had satisfied themselves of the condition of the Kinsman street reservoir, they went to the Fairmount reservoirs and inspected them. The larger of these two reservoirs has been empty for a week or more, and it was free from ice. The Kinsman street reservoir suffered all the more by comparison with the Fairmount reservoirs. Although the latter have sprung slight leaks, which are now being repaired, yet the paving of the basin is regular and solid. Not a stone is displaced, nor any crushed. The Kinsman street reservoir and the two Fairmount reservoirs were built about the same time. The former, after a service of little more than one year, must be repaired at a large cost to the city, while the latter are elegant specimens of good material and thorough workmanship. Several large pieces of soft stone were taken from the bottom of the Kinsman reservoir to be exhibited to the members of the Council. They can be broken to pieces with the fingers and resemble shale."

There is a general opinion that the accident was due to the drawing off of the water. Superintendent Whitelaw, of the Water Department, stated that "If the water had not been drawn from the high reservoir Friday, there would have been no trouble. I examined the reservoir at 3 o'clock Thursday and found the walls in perfect condition. There was then 8 feet of water in the basin. The keeper made another examination at 10 o'clock that night and the walls were still solid. The water was then being drawn off. At 7 o'clock in the morning it was found that the stone paving had been crushed in places. The mischief had been done during the night and was due entirely to the fact that the water was drawn off. There were over 700 tons of ice on the water that settled against the sides, besides the counter pressure of the water. It will cost only $7,000 or $8,000 to take up the 15,500 yards of clay, turn it over and repair the whole reservoir. Now less than a quarter of the paving is damaged, so that it will not cost more than $1,500 to put in the new stone needed. The lining in the Fairmount reservoir was laid on sand that settled before work was commenced on the paving; in the Kinsman reservoir the lining was laid upon clay that is never done settling. The stones in the reservoir were so good that they would stand almost any amount of pressure before crushing. In fact we saw only a few broken stone. In places where the pressure was great from every side the stones would

raise up turtle shell fashion without breaking."

The committee has reported to the council that a large part of the damage at the Kinsman reservoir was due to the sudden drawing off of the water by order from the council and recommends that an examination of the whole matter be made by a committee of competent engineers.

The following letter was sent to the *Leader* by one of the contractors:

As a great deal has been said about the poor material used in the construction of the high service reservoir, I feel it a duty to contradict some statements, in defence of the Water-Works Board and the contractors. Mr. Reader says the paving stone used was soft clay stone instead of sandstone. The stone came from Mr. Herron's quarry and was tested by the Board. It was accepted as good sandstone and comes up to the specifications. I can say, as a contractor who has had experience in building heavy embankments from different kinds of soil, that as the embankments of the high service reservoir were made entirely of dry, hard clay, they could not be built and finished in one year, as they were, without settling out of shape and causing the same result that now appears Great care was used in wetting and rolling the banks, as the different layers were put on, and all material used was inspected by the Board before allowed to be used. The work was done under a competent engineer who was constantly on the work. Mr. Reader would like to have the public understand that if his stone had been used the reservoir would be all right. This is not so. The same result would be shown if they had been built of his stone. It could not stand the pressure brought upon the walls from the settling of the bank. No embankment made of clay, the height and thickness of those banks, will be through settling in ten years. Mr. Reader says that I contracted with him for paving stone, at 95 cents per yard, to pave the high service reservoir. This is not so. I never made any contract with him for stone. When the Fairmount reservoir was let, I had an understanding with Reader to furnish the stone if I was the lowest bidder. This was four months before the high service reservoir was let, and I had no talk with him about stone for that work. The fact is that Mr. Reader has said this out of personal feeling because I did not purchase the material of him, and to advertise his stone and make the public think it superior to all others. These are facts and not wind.

R. FREEMAN, Contractor.

The Black Process.

A black process, which will compete for favor with the well known blue process, familiar to engineers and others, is given in the *Photocopie* of Mr. A. Fisch. The process is technically known as heliography, is simple, easy, and inexpensive, while the prints are ink-black, and are made from drawings or positives and negatives. We owe this process to Mr. Poitevin, but it has been slightly improved.

Sensitizing Solution.—Dissolve separately:

1. Gum arabic	13 drams.
Water	17 oz.
2. Tartaric acid	13 drams.
Water	6 oz. 6 drams.
3. Persulphite of iron	8 drams.
Water	6 oz. 6 drams.

The third solution is poured into the second, well agitated, and then these two solutions united are added to the first, continually stirring. When the mixture is complete, add slowly, still stirring, 100cc. (3 fl. oz. 3 drams) of liquid acid perchloride of iron at 45° Beaumé. Filter into a bottle and keep away from the light. It keeps well for a very long time.

Sensitizing the Paper.—Here especially it becomes necessary to select a paper that is very strong, well sized, and as little porous as possible. By means of a large brush or sponge apply the sensitizing liquid very equally in very thin and smooth coats; then dry as rapidly as possible with heat, without exceeding, however, a temperature of 55° C. (131° F.). The paper should dry in obscurity, and be kept away from light and dampness; notwithstanding all these precautions it does not keep well long, and if it is desired to act with some certainty it is better to have a stock to last only a fortnight. Freshly prepared it is better than a few days afterwards. It should be of a yellow color.

Printing.—The tracing, made with very black ink, is placed in the printing frame, the drawing in direct contact with the plate; then place over it the sensitized paper, the prepared side in contact with the back of the tracing. There is no necessity to make use of photometric bands as the progress of insolation is sufficiently seen on the sensitized paper during the exposure. From yellow that it was, it should become perfectly white in the clear portions, that is to say upon which there is no drawing of the transfer or positive cliche that is to be copied; this is ascertained by raising from time to time the shutter of the frame. The exposure lasts from ten to twelve minutes in the sun; in summer less, in winter more. When the exposure is ended remove the print from the frame, and it should show a yellow drawing upon a white ground. If in the sensitizing bath a few cubic centimetres of a rather highly concentrated solution of sulphocyanide of potassium have been added, this bath becomes blood-red and colors the paper the same; in this case the print also whitens during exposure, but then the image, instead of being yellow, is red on a white ground. This substance, however, is, if we may so speak, inert, or without any other action; it is very fugitive, and even disappers in a short time in obscurity; it has no other use, therefore, than to render the drawing or the image more visible after exposure.

Developing the Prints.—When the print has been sufficiently exposed it is taken from the pressure-frame and floated for a minute in the following solution, so that the side upon which is the image should alone be in contact with the surface of the liquid, avoiding air bubbles between the two surfaces. Otherwise defects would be found in the print; to ascertain this, raise in succession the four corners. The developing bath is composed as follows:—

Gallic acid (or tannin)	31—46grs.
Oxalic acid	1½grs.
Water	34oz.

In this bath the orange yellow or red lines are changed into gallate or tannate of iron, and form, consequently, a veritable black writing ink, as permanent as it. The print is then plunged into ordinary water, well rinsed, dried, and the print is now finished. The violet-black lines become darker in drying, but unfortunately the ground which appears of a pure white often acquires, in drying, a light violet tint. For prints with half tones this is of no importance; but for the reproduction of plans, for example, it is very objectionable. By this process we have the satisfaction of obtaining a drawing in black lines similar to the original, and in most cases this is sufficient.

LITERATURE.

Transactions of the Technical Society of the Pacific Coast. November, 1886.

This number contains a paper by J. Richards on "The High Pressure Hydraulic System of Distributing Power in Cities, with some remarks on Other Methods." Mr. Richards believes that water with its positive action and non-elasticity is the best medium for transmitting power, and that great pressure, up to even 5,000 pounds per square inch, can be obtained by its use. He illustrates by the experience in London and Hull, and points out the objections to other methods of power transmission.

School of Mines Quarterly. Vol. VIII. No. 1, October, 1886.

CONTENTS.—"Earthquakes, by PROF. J. S. NEWBERRY; "Elective Studies," by F. A. P. BARNARD: "On Meteoric Iron from South Carolina," by Wm. E. HIDDENS; "The Mendheim Continuous Gas-furnace for Burning Fire-Brick and Porcelain," by THOS. EGLESTON; "Note on Railway Block Signals," by F. R. HUTTON; "Some Old Gold Mills," by F. N. HOLBROOK; "Line of Origin of the Charleston Earthquake," EMIL STAREK; "Influence of Copper on the Estimation of Sulphur," by Wm. F. BRUGMAN; "In Camp on a Preliminary Survey," by W. H. STUART; "Notes on the Analysis of Chrome Paints," by WALTER LE BROWN.

Proceedings of the Engineers' Club of Philadelphia. Vol. V., No. 5.

CONTENTS.—"The Pressure and Composition of Natural Gas," by Dr. H. M. CHANCE; "Notes upon the Early History of Water Power for Supplying the City with Water and the building and re-building of the Fairmount Dam," by FREDERIC GRAFF; "Calorimetric Tests of Boilers," by J. E. CODMAN; "Taper of Steam Jets," by GEO. R. HENDERSON; "Movement of Ice in the Delaware River," by SPENCER C. MCCORKLE; "The Investigation of the Movement of Freight and Passengers in Cities," by G. MORDECAI; "A Curious Freak of Mild Steel," by SAMUEL T. WAGNER.

SELECTED MISCELLANY.

M. POPP, an Austrian inventor, is charged before the Paris courts with defrauding Sir Montague Call and several other English investors out of 445,000 francs by selling them a process for extracting gold from the rock from which mill-stones are made, and other rock quarried near Paris. Strange to say, the purchasers could not successfully repeat the process.

A FRENCH inventor proposes to use electricity for bleaching paper pulp in the following manner. A solution of chloride of magnesium is used. This is of the strength of about 16 degrees Beaumé. On passing a current through, electrolysis taking place, various chemical reactions occur, setting free divers oyxchlorides, which, so it is said, effectively bleach the fibre.

THE Russian government is now engaged in draining the Pinsk marshes, in southwest Russia, near Galicia. They have been a wilderness refuge for all manner of romantic characters in past times. With a large engineering staff and several thousand troops about 4,000,000 acres have already been reclaimed by ditches and canals in some cases large enough to take craft of several hundred tons. Next year 350,000 acres more will be drained by 120 miles of ditch and canal. Besides this work the Russians have built in this region 179 bridges, dug 577 wells and mapped 20,000 square miles of hitherto unknown country.

STEAMLESS ROAD LOCOMOTIVES.—In order to render invisible the escape steam of tramway and other road locomotives, Mr. B. C. Parsons, of Leeds, provides in a boiler of the locomotive type two sets of tubes, the one set of comparatively small diameter, and the other set of larger diameter, each set being capable of being more or less closed at the smoke box end of the boiler by suitable slides or valves under the control of the driver. When the driver observes that the steam issuing from the chimney is more or less visible, he closes, more or less, the small tubes and opens, more or less, the large tubes, thus admitting to the smoke box a greater amount of heat from the fire, which has the effect of rendering the steam invisible.

BASIC SLAG AS A MANURE.—At a meeting of the Darlington (England) Chamber of Agriculture, on November 29, Prof. C. F. Hope read a paper on "Autumn Manuring," in which he said there was a new manure, basic cinder, of high value, which he would advise the farmers of that district to look to, and which he had no doubt would come into considerable use. In the manufacture of iron, phosphorus was an exceedingly detrimental ingredient, and at Middlesborough and other places where iron was made the slag or refuse which contained this phosphorus had accumulated to a great extent; indeed, there were comparative mountains of it. What was known as the basic slag or cinder had recently been found of great manurial value owing to the phosphates in it. Several experiments had been made, and there could be no doubt as to the benefit to be derived from proper dressings of it. The basic cinder was sold last year at about $5 per ton, and he believed a good deal more money would be wanted for it next spring. If basic cinder could be had at anything like the present price he would advise farmers to apply it whenever phosphatic manure was required.

THE WORLDS POPULATION.—The population of the entire world is estimated at about 1,424,000,000. The so-called census returns of Chinese officials are generally regarded as utterly untrustworthy. The latest reliable computation of the inhabitants of China is that of Mr. A. E. Hippesley, of Shanghai, which places the population of China proper at about 250,000,000. To this must be added 31,699,000 for the territories and Corea, bringing the total population of the empire up to 281,699,000.

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THE article on the Municipal Engineering of Philadelphia, now being published, was written for this journal by Dana C. Barber, Sanitary Engineer, of Philadelphia, Pa.

OWING to serious illness in the family of one of our staff and his consequent absence, we must apologize for typographical errors, etc., in our last issue; they were all corrected by the proof-reader, but, lacking supervision, were not corrected in the forms.

THE coming together of the various headings of the New Croton Aqueduct is now a thing of the very near future as will be seen from our "progress profile" of last week. In fact, six headings are now "holed," though the finished tunnel is as shown on the profile.

Engineers are looking forward with considerable interest to the "meeting of the lines," and the following is the official result as obtained in the tunnel between Shafts 20 and 21: These headings were joined on the night of December 12th; the variation from the true alignment was .025 feet, and the variation from true grade, .045 feet. This is very good when we consider that in the heading from Shaft 20 there is a 10° curve, 210.4 feet long, with an intersection angle of 21° 2′ 30″. The distance between the two shafts is 5,480 feet, the longest continuous stretch of tunnel yet opened.

Mr. W. W. Olney was the engineer-in-charge, and Messrs. H. E. Collins, A. M. Nevin and P. Dorsey were the first men through.

WE have already referred to the paper "On Steel for Heavy Guns," to be read by Mr. E. Bates Dorsey, C. E., on January 5th, before the Naval Institute at Annapolis. From present indications a very lively and a timely discussion of this interesting subject will follow the presentation of Mr. Dorsey's rather radical views.

Many prominent engineers and steel-workers agree with the author that hard steel, made by the open-hearth process, and as called for in the specifications of the U. S. Ordnance Bureau of the army and navy, can not be considered a safe material for heavy guns; at least, with our present knowledge of its properties. In fact, we consider this material utterly unreliable when used in the great masses called for by the size of modern guns; and in this we are supported by some of the best engineering authorities in the countries where guns so made have already been tested and practically found wanting.

A material rejected by bridge builders and boiler makers because of its unreliability under sudden stress is certainly not the stuff to put into guns that are supposed to successfully resist the most abrupt and violent of shocks to which the materials of construction could possibly be subjected.

Mr. Dorsey suggests mild steel for his guns, a material that is found in abundance in our market and of most excellent and uniform quality, and in this stand he is endorsed by the best of our experts. It is an experiment well worth trying and we would recommend ample appropriations to make the trial. The very peculiar economy that has so long denied to our ordnance officers the means for testing the qualities of home material and American ideas in gun-making has too long been a standing reproach, and is the true reason why our officers have had to depend for their knowledge upon such reports as foreign experimenters saw fit to make public. When forced to it by circumstances we made the heaviest and best cast-iron guns in the world, and with our present great advance in the knowledge of the material and its manipulation we see no valid reason why we should not meet with similar success in the use of steel, either assembled in a number of thin tubes, as suggested by Mr Dorsey, or even cast at a single operation where weight was no objection.

True economy would seem to us to point towards very extensive experiments with these new materials and processes, rather than towards the blind copying of a type of gun that the very makers are almost afraid to fire and are now condemning. An armor-piercing gun is an extremely expensive machine as built abroad; a 115-ton Armstrong costing, we believe, very nearly $200,000, and is credited with a life-time of 60 shots after it leaves the testing-ground. At this rate, each service shot would foot up to something like $3,300, without counting the cost of the 2,300 pound projectile, or the 800 pounds of powder required to propel it. If we can make guns of only equal life out of a much less expensive material and by cheaper processes the gain would certainly warrant all the expenditure necessary to put the theory to the test.

County Commissioners and County Bridges.

A correspondent who finds fault with the popular method pursued by County Commissioners in the selection of country bridge designs sends us a specimens of late Ohio erection.

One diagram shows the figured strains and actual sections of the bridge as erected; another exhibits the proper figuring in both cases by very competent authority. We will not at present mention the name of the makers; it is sufficient to say that the structure is of sufficient importance to have two 190-feet spans and is supposed to be designed to carry a live load of 3,300 pounds per lineal foot. The contrasting diagrams show a wide discrepancy in the sections of the members throughout the erected bridge, and sections all vary considerably below the strict, safe requirements.

This contract was won by its cheapness as compared with other and better designs. And, as the average county commissioner is probably as well posted in stress diagrams as in Chinese literature, we can suggest no sure prevention of similar acceptances, until the system is changed and reputable engineers be selected to do what it is strictly in their province alone to do. The same farmer who would not hesitate to pronounce judgment upon the fitness of a bridge, over which he and his neighbors will probably daily pass, would be about the last person to select an engineer as his agent in the purchase of live stock, or consult him in the management of his farm. Yet the engineer is very likely infinitely more competent to give the farmer advice than is the latter to pick out a bridge or similar structure.

As county commissioners will doubtless continue to be selected from the prevailing class, the only remedy we can suggest is to force them, by legal enactment, to be guided by a thoroughly competent engineer in all matters where human life is at stake; and to make it a crime, for which the commissioners can be punished, to take any definite action without expert advice. The same law should see to it also that the engineer employed is held responsible for his jugment and is properly paid for his services. Two ends would be served by the latter clause; the commissioners would be estopped from carrying their economical ideas into the selection of their consulting engineer, whereby they could secure both a cheap engineer and a cheap bridge; and in the second place, if the engineer is held personally responsible for the soundness of his experience and judgment, the professional quack would perchance step aside.

Extreme and unreasonable cheapness in bridges, like in all other wares, can only be secured through the medium of scant and bad material and scamped workmanship. And we regret to say that makers can nearly always be found to meet this class of demand.

The French International Exhibition of Railways for 1887.

We have already noted the proposed International Exhibition of Railways to be held in Paris from May to November, 1887. We are now in a position to give some further particulars of this intended celebration of the fiftieth anniversary of the introduction of railways into France, and the progress made to date.

The exhibits will include material relating to the history of railways and instruments connected with their location; appliances used in constructing, protecting and working lines; terminal and other stations; rolling-stock of all types and classes, including horse and steam tram-ways; the general manage-

ment of railways; the application of electricity to railroads and publications, statistical and otherwise, relating to railways.

The scheme has the government sanction of France and the exhibition will be held under the honorary presidency of the Minister of foreign affairs, President of the Council and the Ministers of public works, commerce and industry, war, naval, posts, telegraphs and agriculture, including M. Ferdinand de Lesseps.

Mr. John W. Weston, the Commissioner for the United States, gives us the following detail of progress to latest Paris date:—The members of the French committee, composed of 200 prominent men, are located in various parts of France and are working in connection with the French press to make this railway jubilee a grand practical success. The French Chamber of Commerce and various professional societies have requested space and permission to participate; M. de Freycinêt, the late President of the Cabinet, has added his name to the Honorary Presidents; some of the chief railroads of Great Britain have applied for extended space; Brazil has entered entnusiastically into the enterprise and other distant lands, even China, have already signified their intention to take part in the jubilee. According to foreign customs, a strong committee of patronage has been formed by the Commissioner General of England and the leading railways have named delegates to the coming congress of railway men which forms part of the scheme. The English Chambers of Commerce have taken similar action and have nominated as their delegates, Sir Frederick Bramwell, President Institution of Civil Engineers, and Sir Phillips Cuncliff, Director General of the South Kensington Museum, Sir J. Bazalgette, C. E., Metropolitan Board of Works, Sir Charles Bright, Sir C. C. Owen, etc., etc., who are all actively engaged in advancing the interests of this enterprise, and the press of Great Britain is equally friendly. In all eight Commissioners General have been appointed for foreign countries. The English railways named as intending to exhibit are: The South-Eastern, Great Northern, Metropolitan District, London, Chatham & Dover, London, Tilbury & Southern End and the North London Railway, all prominent corporations.

As yet our chief American lines have not expressed their intentions with regard to this coming railway exhibition. With their usual apathy when a foreign exposition is concerned they seem content to allow our neighbors across the sea either to guess at the condition of railway affairs here—and guess wrongly, as they usually do—or to come over and find out for themselves by a hasty and unsatisfactory inspection. This is all wrong, and is one reason why, in the late lively discussion over rates, management and constructive details in England, countries like Belgium, Sweden, and even less important railway centers are covered in comparative tables which entirely omit a country that has over half of the railway mileage of the world.

We have many reasons for letting the Old World know what we are doing in this direction, sound commercial and financial reasons. We have goods to sell and a trade to encourage, and from another stand-point have very many millions of railway securities held abroad by people who would like to know more about our methods and financial standing. We have little fear but what our manufacturers will be well represented, at least in quality, if not in quantity; but we earnestly hope that our great trunk lines will take steps, as have the English, to show what powerful factors they really are in the commercial world.

Report on the Irrigation Canals of Colorado.

Walter H. Graves, C. E., has just submitted a tabulated statement of the irrigation canals of the State of Colorado. The following is an abstract only, including the more important canals:—

The San Luis valley canals include the *Citizens* and *Del Norte*; the first ten miles long, with a theoretical capacity of about 1,000 cubic feet per second; and the latter thirty-four miles long with fourteen and one-half miles of main laterals, and a theoretical capacity of about 2,500 cubic feet per second. In regard to the number of acres that will be irrigated by these canals, Mr. Graves says it is simply impossible to give any exact statement. It involves the whole question of the *duty of water*, a question upon which no two men will agree. The first canal enterprises were started in Colorado by the "English Company," and they originally selected three of the most successful farmers as examples, and averaged the amount consumed by them. This empiricism was accepted and adopted, and has grown into almost universal custom.

This "standard water-right" gives to eighty acres 1.44 cubic feet of water per second; an amount that would cover eighty acres 14 feet deep in a year, or equivalent to an annual rainfall of over 14 feet. Mr. Graves believes one cubic foot per second over 100 acres would be a more reasonable standard; as this would be equivalent to a rainfall of about 25-inches for the irrigation season of 100 days; or an annual rainfall of over 7 feet in addition to the natural rainfall which, in Colorado is nowhere less than 8 inches. When water is first applied to raw land a much larger quantity is required than ever after, and this quantity decreases gradually through a long term of years as the soil becomes more compact and silted. Mr. Graves therefore estimates that the *Del Norte* canal will irrigate from 200,000 to 225,000 acres, and the *Citizens* canal about 100,000 acres; he thinks it safe to sell not over three-fourths of the estimated capacity of these canals.

The *Grand River* canal system includes nearly 27½ miles of canal and 25 miles of main laterals, together with the *Mesa County* ditch of 9⅝ miles, and the *Independent Ranchmans'* ditch 42½ miles; the extent of small laterals is about 20 miles and nine miles of constructed waste channels. The theoreticel capacity of the *Grand River* is 450 cubic feet per second; of the *Mesa*, 220 feet per second. The channel of the first named has been in a deplorable condition, but Agent Costa has largely improved it in the past two years. The locality is one of the most promising in the mountain; fruits, cotton, tobacco, peanuts, almonds, etc., can be grown. About 14,000 acres are in demand.

The *Uncompahgre* canal has 30½ miles of main line and about 20 of main laterals, with a capacity of about 700 cubic feet per second; though on the first 14 miles the present capacity is not over 375 feet. Three years from date it can supply from 35,000 to 40,000 acres; though at present it can barely supply 20,000 acres. The constructive work on this canal is unexcelled. About 3,600 acres are now supplied, and next year this may reach 9,000 acres.

The *Fort Morgan* canal is 28½ miles long with 12 miles of main laterals and a capacity of 280 cubic feet per second. About 18,000 acres are "under" the canal; a greater quantity than it can supply without enlargement of the flume and a strengthening of the canal; about 12,000 acres can be supplied.

The New Aqueduct Civil Service Rules.

The special regulations applying to the Aqueduct Commission of New York for the examination of applicants are now in service, and in effect are as follows:

A special Board of Examiners is to be organized, composed of two civil engineers to be designated by the Aqueduct Commission and approved by the Mayor, the civil engineer of the Examining Board and the Chief Examiner. For the higher positions—assistant and division engineers—the examinations will include tests for technical competency, backing by previous record of service. For the minor positions, the tests will include those for health and vigor, handwriting, arithmetic, and questions on technical knowledge required for the position.

When competition may not be found practicable to meet an emergency, the fact must be noted by a certificate from the Commission; and the position can be temporarily filled, but no such appointment shall hold longer than three months.

Persons in the employ of the Aqueduct Commission prior to September 7, 1886, and who have a certificate from the President and Chief Engineer showing that they been employed after a careful examination into their qualifications and whose service and conduct is acceptable, will not be required to pass any further examinatien. In other respects all Aqueduct employés will be subjected to the civil service rules.

PERSONAL.

EDWIN SUTPHIN is Superintendent of the new water-works at Clyde, Kan.

MR. BOUSCAREN has been appointed engineer to the Board of Reservoir Trustees, Covington, Ky.

FRANK A. HILL has been apointed Chief Engineer of the recently incorporated Sioux City & Northeastern R. R., and will enter upon his duties at once.

DANIEL A. TOWER has been appointed Superintendent of the new water-works at Cohasset, Mass.

WALTER SHEPHARD has been appointed Assistant Chief Engineer of the Boston & Albany R. R., in place of George R. Hardy, resigned.

M. DE LESSEPS has given $400,000 for government land along the line of the Suez canal, to be used in the work of widening the waterway.

J. R. STRAUGHAN, of Terre Haute, Ind., is Chief Engineer of the Indianapolis, St. Louis & Western R. R. Co., recently incorporated; OLIVER W. BARNES, of New York City, is Consulting Engineer.

H. W. CLARKE, C. E., of Syracuse, N. Y., reports progress on an official map of that city upon which he is now engaged. The work is being done on a scale of "40 feet to the inch," and judging from his report will be very complete.

WM. D. KELLY, JR., and E. F. PLAYLE were appointed Assistant Engineers on the New Croton Aqueduct on December 22.

CHARLES SHALER SMITH, one of the most prominent American engineers in bridge construction, died at his home in St. Louis, Mo., on December 19. MR. SMITH was for a long time President of the Baltimore Bridge Company, and was the designer of the now famous Kentucky River bridge, the first application of the cantilever system to bridge construction in this country. He later designed about all of the bridges on the Canadian Pacific R. R. and also on the Chicago, Milwaukee & St. Paul R. R., including the important Sabula draw-span. Mr. SMITH was elected a Member of the American Society of Civil Engineers on March 5, 1873.

B. R. DUNN is Engineer of Roadway of the Atlantic Coast Line R. R.; M. W. DEVINE has been appointed Roadmaster of the Wilson & Fayetteville and Tarboro branches of the Wilmington & Weldon line, and the Albemarle & Raleigh line, with headquarters at Wilson, N. C.; T. J. WHITTEN has been appointed Inspector of the Wilmington, Columbia & Augusta line

and the Central and Northeastern lines of South Carolina.

R. A. CHAPIN, C. E., of Livingston, Ala., has returned to his home for the holidays. He has been engaged for two months in laying off small farms along the line of a Southern railroad; he has several months work of this class already engaged and has plenty of work as settlers are unable to get their property located as fast as they desire.

DAVID COLEMAN, Division Superintendent at La Crosse, Wis., of the Chicago, Burlington & Northern R.R., died suddenly on December 10th, at Topeka, Kan., where he had gone to fetch his family to La Crosse. Mr. Coleman had been with the road since it was first projected and was originally in charge of tracklaying. He was formerly Roadmaster on the Atchison, Topeka & Santa Fè R. R.

T. S. MOORHEAD is Vice-President and Chief Engineer of the Wilkesbarre & Western R. R., the line is under construction from Watsontown, Pa., to Shickshinny and has been opened to Lethergo station, Montour county. R. T. MCCABE is President and General Manager; WM. B. CHAMBERLIN, Superintendent; and S. H. HICKS, Secretary. The company's office is at 42 New street, New York City.

WILLIAM H. STEVENSON has been appointed General Manager of the New York & New England R.R. He was formerly Superintendent of the Consolidated R. R.; and WILLIAM H. WALLACE, of New Haven, Conn., formerly Assistant Superintendent, has been promoted to be Superintendent.

COL. G. J. FORAKER died in Newark, recently, aged 58 years. He was General Superintendent of the Trans-Ohio Division of the Baltimore & Ohio R. R. during the last three years. Previously he had been President and General Manager of the Atlanta & Charlotte R. R., General Manager of the Virginia Midland R. R.; General Superintendent of the Georgia Pacific R. R., and President of various narrow gauge roads in the south.

WM. P. SHINN, Am. Soc. C. E., and late of the New York Steam Heating Co., has been elected Vice-President of the New York & New England R. R. Co., under its new management. Mr. Shinn was formerly President of the Allegheny Central R. R., and later was connected with the Pittsburgh & Fort Wayne R. R. as General Superintendent.

Engineers' Club of St. Louis.

MEETING OF DECEMBER 15, 1886.

The club met at 8:15 P. M., at Mercantile Library, President McMath in the chair, and nineteen members present. The committee reported the election of the following officers: President, Prof. W. B. Potter; Vice-President, M. L. Holman; Librarian, Prof. J. B. Johnson; Secretary, W. H. Bryan; Treasurer, Chas. W. Melcher; Directors, R. E. McMath and Wm. Wise. The chair appointed J. A. Ockerson and M. L. Holman a committee to escort the newly-elected President to the chair. Prof. Potter on taking his seat addressed the members briefly, thanking them for the honor conferred upon him, asking their co-operation in furthering the objects of the club, and assuring them of his desire and intention to do all in his power to make the year one of interest and profit. He then called upon the retiring President for some remarks appropriate to the occasion. Mr. McMath in responding addressed the club at some length on the present and future status of the engineer, his connection with the national public works, and the prospects of improvement in his condition. The subject of compensation was also touched upon, and the advantages of a closer union among engineering societies were pointed out. The address was received with applause, and the following resolution was introduced and adopted:

Resolved, That this club appoint a committee of five to consider the subject of a closer connection of existing societies, with a view to forming a general organization.

On motion it was decided that the committee be appointed by the chair. The committee was constituted as follows: R. E. McMath, M. L. Holman, J. A. Seddon, Robt. Moore and Wm. Bouton. The Secretary read a communication from the Secretary of the American Society of Civil Engineers, acknowledging receipt of the club's letter adopted at the last meeting. The Secretary also read a communication giving the results of the American Society's inquiry into the subject of changes in its organization. But one society—the St. Louis—had expressed an opinion, and only six of the 763 members addressed had replied.

A paper by Prof. F. E. Nipher, an the "Economic Co-efficient of the Shunt Dynamo," was then taken up. The Professor gave a mathematical discussion of the theory of the efficiency of this class of machine, and showed the conditions under which a maximum was reached. The life and resistance of incandescent lamps was also touched upon. The subject was discussed by Messrs. Flad, Seddon and Bryan. Prof. Nipher also spoke briefly on the subject of discrepancies in measurements of rainfall in gauges at varying heights. Adjourned.

WM. H. BRYAN, Secretary.

Liverpool Engineering Society.

The usual fortnightly meeting of this society was held at the Royal Institution, Colquitt street, Liverpool, on Wednesday, December 1st. The retiring president, Mr. Coard S. Pain, Assoc. Inst. C.E., delivered an address on the "Depression of Trade as Affecting Engineering." After speaking of the difficulty in arriving at any satisfactory reason for the universal depression experienced, he proceeded to compare the present condition of the iron trade and that under which future trade would have to be secured.

Statistics culled from the evidence given before the Royal Commissioner on Depression in Trade were quoted, showing the estimated consumption of iron per head of the world's population as well as the consumption by individual nations. The next table showed the various uses to which the iron raised in the world was applied as far as could be ascertained, from which it appears that about one-fourth of the whole quantity raised is rolled into iron rails, hence the selection of the iron trade as that by which the position of engineering may be gauged. The prospects of this country as regards the future supply of railway plant, ships, &c., was then considered, followed by an inquiry into the cost of production.

The interesting questions of natural resources, wages, royalties, railway rates, and food in the different countries were entered into, from which it was argued that on the whole Great Britain was not unfavorably situated for competing in the world's markets. In conclusion the author touched on the respective influence of capital and education, remarking that whilst capital was necessary to the development of trade, its individual acquisition, without reference to the welfare of the community, was productive of evil, and that whilst it was desirable to educate the artisan to enable him to earn money, it was equally, or more, necessary to educate those who amassed fortunes to enable them to judiciously expend them, and that all should interest themselves in those subjects of vital importance to the community on the ground that the greatest weal was the common weal.

COPYING PRINTED AND OTHER MATTER.—Printed matter may be copied on any absorbent (unsized) paper by damping the surface with a week solution of acetate of iron and pressing in an ordinary copying press.

Old writing may be copied on unsigned paper, if wet with a weak solution of sulphate of iron and sugar water.

CORRESPONDENCE.

Will Steam-Pipes Ignite Wood?

STILLWATER, MINN., December 9, 1886.

EDITORS ENGINEERING NEWS:

I have got into a discussion here with the insurance men, they say steam-pipes will set buildings on fire, or rather the bet was made that "Steam pipes from heating furnaces will set wood on fire."

I claim that steam-pipes cannot set wood on fire; of course we understand steam-pipes will help spontaneous combustion, but that you cannot get enough degrees of heat from steam generated from a boiler, without superheating it, to set wood on fire. I have been covering steam boilers and pipes for twenty years with all kinds of wood and never heard in any case of the wood igniting. Locomotives are covered (boiler and steam dome) with soft pine and they carry a high head of steam, from 100 to 200 pounds to the square inch, it stains and chars the wood but all railroad engineers agree that there is not enough heat to ignite the wood. Would like your opinion.

Truly, H. H. HARRISON.

[We have submitted the above to several experts, among others to Mr. P. B. Armstrong, Secretary of the Mutual Fire Insurance Co. Mr. Armstrong has made a study of this subject for many years and courteously gives us the following as the practical results of his experience:—

He says that he has no hesitation in stating that under certain circumstances "steam-pipes will ignite wood." "It is not the great heat generated in the pipes that produces the fire. Steam-pipes at a very low temperature, when in contact with wood, will conver the same into charcoal; and, in long lengths of pipes, electricity will generate, and, as charcoal is one of the best conductors of electricity, we believe the electric spark is more likely to leave the pipe when the latter is in contact with charcoal than to continue in the length of the pipe, and from this cause fire is likely to ensue."

Mr. Armstrong says further that the fine lint which accumulates in all large establishments using steam, may, under certain circumstances, be more readily ignited than charcoal itself; but, "between the fine lint and the charcoal fire is started." He details a number of cases in point coming under his observation. In a large chair factory in the west the steam-coil in the dry room rested on wood and was almost embedded in charcoal; on condemnation the proprietor stated that the pipes had been in that position for twenty-five years and he apprehended no danger. Within two weeks however this dry-house was burned down under circumstances pointing to this coil as the seat of real trouble; no other cause could be given for the fire. Other fires are noted originating in private offices, about the steam-pipes, while the owners were seated in them; wood was in contact with the pipes. In a frame planing-mill in Ohio a pipe for a steam whistle passed through an inch auger-hole in the roof; this whistle was sounded at noon, and in a few seconds thereafter the boards around the pipe were in flames. Mr. Armstrong thinks that when there is a free circulation of air about the pipe the danger is not as great as in the case of pipe passing through floors or ceilings. He says "the only safe rule in reference to steam-pipes is to have wood or other combustible material thoroughly protected, or kept away from steam-pipes entirely." Wood covered completely with tin is an absolute protection.

Another authority refers the writer to "Steam Heating Problems," a publication generally credited to Mr. Wm. J. Baldwin, a steam-heating engineer of considerable experience. In "A Supposed Case of Charring Wood by Steam Pipes," this author remarks as follows: "A temperature of 308° Fahr. (the temperature of 60 pounds of steam) is generally considered not sufficient to make charcoal from the most easily burned woods; but in the case of boilers and steam-pipes, too much dependence must not be placed on this supposition, as continued superheating of the steam by an improperly set boiler, may be the means of giving much higher temperatures. Assuming that a temperature due to 60 pounds of steam at maximum density cannot char wood, steam can be superheated without materially increasing its pressure until it will make the pipe through which it passes red."

It would thus seem that while the conversion of wood into charcoal by heat from steam-pipes can not be technically called "setting the wood on fire," and is not necessarily dangerous; yet this charcoal may under certain accompanying conditions lead to a fire. The wood covering on boilers, pipes and engines would come under the class "exposed to free air circulation," and can hardly be held up as an example of wood in contact with floors and ceilings. In the latter cases we think Mr. Armstrong suggests the only safe rule.

ED. ENG. NEWS.]

American Society of Civil Engineers. Next Annual Convention.

EDITOR ENGINEERING NEWS:

The members of this Society will soon be called upon to vote where the next Annual Convention shall be held.

I suggest Pittsburg or some place in its vicinity, say Cresson, the latter is a pleasant summer resort, situated on top of the Allegheny mountains, of easy access by the Pennsylvania Railroad, and only ten hours time from New York.

No place offers greater attraction to the engineer than Pittsburg and its vicinity, which includes large iron works, steel works, glass works, coal mines, natural gas wells, oil wells, at Altoona one of the finest railroad shops in the world, and many other objects of interest.

The situation is very central, and can be easily reached by the majority of our members.

EDWARD BATES DORSEY, M. Am. Soc. C. E.

Adjustment of the Wye Level.

CHAMPAIGN, ILL., December 20, 1886.

EDITOR ENGINEERING NEWS:

Mr. Pearson, in the last issue of the NEWS, calls attention to an omission in my article on the wye level. He is correct, the difference between true and apparent level should not be neglected. The easier method of taking this into account is to correct the longer sight for curvature and refraction; this is implied in my article, but should have been stated. In Mr. P.'s example, the distance is 646 feet, nearly two and a half times 225 feet, and the correction is $(2\frac{1}{2})^2 .001$ foot $= .006$ foot at once (see page 358, second column, near the bottom.

Mr. P's second criticism is owing to another omission in my article; it is implied that the second position of the instrument must be in line with the two stakes, the formula (page 357), could not be true for any other position.

I. O. BAKER.

Water Meters.*

BY J. A. TILDEN, MEM. OF THE BOSTON SOC. OF C. E.

[Read November 17, 1886].

It is the intention of this paper to sketch the development of the water meter as a mechanical device. All questions as to its value as a means of checking waste and as a method of equitably adjusting rates are not considered here, but may be said to be answered by the constantly increasing demand for an efficient and cheap meter.

The history of its development as a piece of mechanism may be traced in the Patent Office; and it is from the patent records of the United States, England, France and Germany, and from a few scattered publications, that the data of this article are taken. The observations submitted are the result of practical experience in a long series of experiments, and are offered simply as opinions.

It is remarkable that upon a subject of such importance so little has been written. The same unprejudiced thought and study as has been given the steam and other engines is entirely wanting. It appears to have been studied only by inventors and experimenters who have carefully guarded their work and reserved their conclusions for themselves. Every other form of engine or motor (for a meter is but a special adaptation) has been fully elaborated, and there are many authorities upon every subject theoretical or practical connected therewith, while upon the water or fluid meter information as to its mechanical or operative details is almost entirely wanting. It was on this account that the Patent Records were searched as a record of experimental work. As to their value as a source of information or authority, it will be seen that each specification must be read with caution, as many conceptions therein described do not even reach the experimental stage, while by far the larger proportion are abandoned by the time the patent is printed. A search as to novelty should comprise, and in the United States Patent Office does comprise, not only the class of meters but that of engines, motors and pumps, and of specific parts. A task of this kind is truly formidable, for to be complete it should comprise a search of record in all patent granting countries.

The United States patents—class of meters—number at this reading five hundred and fifty-two; those of England and Colonies nearly as many more, and the number is well approached by the sum of those of France, Germany, Belgium and others. Here will be found the names of well known engineers who have considered the water meter worthy of their expert attention, and who have produced some very excellent machines; while on the other hand, it has decidedly suffered at the hands of the entirely inexpert and ignorant, who have succeeded only in shrouding it in a kind of mystery and in producing the common impression that a successful meter is about as unattainable as perpetual motion. While an enormous amount of money has been expended in experiments, the total number of patents probably representing but a part, only a small portion has been utilized in well executed design, as shown by the very few efficient devices in the market. If this statement is true, there must have been some special difficulty peculiar to the problem. It can be shown that if one element, that of cost, were eliminated, mechanical defects could be easily overcome. Efficient and cheap it must be in order to meet a demand which does not exist for a high-priced machine. it is the cost at which it must be produced which makes its duty and requirements in excess of almost any other automatic machine.

There are a number of excellent meters in use whose operation may be said to be practically all that is desired, their limited application being not on account of any defect, but because of their high price, which arises from their size, weight and cost of manufacture. It may be noted here, that in a comparison of economy of meters, durability and permanency are as great a factor as price.

Ideas of what constitute efficiency vary with almost every water department. Special prominence is generally given to one particular feature to the oversight of others of equal or greater importance. However, they average up about as follows: To be efficient, a meter must be accurate within a permissible error, under extremes of pressure and rates of flow of perhaps two per cent. in favor of either department or consumer, and must maintain this standard with a reasonable, or rather an unreasonable, degree of permanency. It must not materially or noticeably retard the flow or diminish the pressure, and should be able to pass, without stopping, clogging or breakage, substances often carried along with the water, such as sand, sediment, pipe scale, etc. It must be able to withstand without damage water hammer caused by sudden closings, and in itself produce none, or make any noise from its working parts. Altogether, it must be compact, of non-corrosive material, inexpensive in repairs, and capable of standing abuse rather than use. It will be observed that a number of these requirements are not inherent in a measuring apparatus, but have been introduced by the defects of meters themselves.

Of the United States patents on meters two hundred and thirty-nine are of the piston type, one hundred and eighty-three are rotary, fifty are diaphragm, and eighty are oscillating. There are in addition a number of miscellaneous which admit of no large classification, such as those of the purely inferential and proportional type.

The reciprocating piston meter in its severally perfected forms is a practical measuring device, its efficiency being limited only on account of its large cost arising from the expensive non-corrosive materials used in a necessarily bulky construction. The mechanical problems of a piston meter have been fairly met. It is required that a piston be forced by water controlled by a suitable valve device to traverse a cylinder and return to its starting point. The amount of water displaced or measured per stroke is equal to the area of the piston into the distance which it travels. Connected with a properly constructed counter or register the mechanism is complete. According to the records it would appear that this class of meter was as near perfection thirty years ago as it is to-day. Of more than two hundred United States patents in this line, but two or three have met with popular favor and are able to meet the market at anything approaching the required price. The others, which in many instances show great ingenuity, have either misconceived the object sought for or utterly failed mechanically. Many large and costly meters have been designed under the impression that there were no good piston devices in use. These, of course, although they may be efficient, are unavailable on account of their cost. The mechanical failures above mentioned are in most instances absurdities in the outset.

The best forms of the steam pump and other piston engines have their adaptation in more or less practical water meters. A special arrangement of the parts is made whereby the valve mechanism is entirely inclosed, and in such manner that there are no moving parts or connections outside the case. The duplex pump is represented in a double plunger meter in which a pair of double-acting plungers operate in conjunction with a pair of slide valves. The single pump is represented in various forms of single piston meters in which the valve gearing is operated by a supplemental piston and valve, or by weights, springs, etc. These and other modifications of reciprocating engines, while quite effective are large and heavy, and consequently costly.

In order to come within the narrow limits of price, many attempts toward a reduction of size and weight have followed, and as a result, some of the special requirements of a meter have been sacrificed. As an instance, in the attempt to make a single piston do the work of two an infinite variety of valve mechanisms have been devised with a view of obtaining the same easy movement found in the best double piston meters. The uniform results have been that either the single piston meter must be made large enough to equal in capacity the double piston or one of the following defects would ensue:

First: A mechanical noise caused by the striking of the moving parts, such as would come of the use of levers, weights or springs in obtaining a reverse movement of the piston, or in the use of a supplemental valve, by the main or auxiliary piston striking its bunters.

Second: Water hammer caused by the checking of the flow at the instant of reversal of the main valve; or, third, if this is avoided by the use of poppet or open, slide or piston valves, an annoying inaccuracy of registration ensues from the varying loss of water under different conditions at the time the valve is changing. The double piston in one of its best forms operates upon precisely the same principle as the steam end of a duplex pump, the piston, or plunger as it is in the meter, moving a slide valve which controls the water for the other plunger, which in turn operates a valve for the first. All piston, valve and connecting rods are dispensed with, as the valves are inside of the case, and moved by direct contact with the plungers.

* From Journal of the Association of Engineering Societies. Vol. VI. No. 1.

Attempts to lessen the high cost of this design have led to a great many experiments, such as the dispensing with the valves by the use of one piston as the valve of the other, by placing one inside of the other, by placing them at right angles, by the use of one rotary or slide valve operated with or without cranks and in every other conceivable relation. All this with poor success in the way of a meter at a less cost, serving only to complicate parts or introduce some peculiar defect of its own.

Vibrating or oscillating pistons have been tried in many forms with little satisfaction, as the increased cost of construction overbalances the reduction in weight.

Flexible diaphragms have been substituted for the piston, and combined with every valve gearing found in the piston and oscillating types, but still the diminution of size and weight is not found.

The opinion is submitted that almost any positive displacement device constructed on good mechanical principles, and, of course, specially adapted for the work, would be a mechanical success as a measuring apparatus, and would be a commercial success were it not for the rigorous lines drawn by the very limited price at which it must be produced and sold. In the attempt to meet this cost feature by a diminution in size, overwork of one or moreparts or a general overcrowding is the inevitable result, causing either rapid wear or some of the immediate annoying defects, such as mechanical noise, water hammer, stopping, small capacity, inaccurate or uneven registration, etc.

There is a large class of inferential meters which come under the head of Rotaries; all measuring wheels, turbine screw and reaction come under this class, as they infer that for a given number of revolutions a certain amount of water will pass. It can be seen, and experience has proved that, only an unsatisfactory approximation is the result. Many, however, are yet in use in England, Germany and other foreign countries, as the piston meters made and in use there are very expensive. The purely inferential meters are those which infer that a certain amount of water will pass through an orifice, the size of which is controlled by the flow. Registration is obtained and figured from a recording gauge, which is operated by a piston or other valve at the orifice. A degree of success has been obtained in this way on large pipes.

Proportional meters were among the earliest conceptions for the registering of water in large quantities. In these a relatively small portion is deflected from the main pipe and measured by positive displacement, the principle being that the fluid will divide proportionally under relatively equal resistance. It has been found that, on account of the varying retardation of the metered part under the different conditions of pressure and flow, a regulating valve of great delicacy is required to deflect the proper quantity from the open pipe to the meter, according to the reduction of pressure at the point of discharge. The serious defects are, first, the multiplication of error, which is in the same proportion as the unmetered part to the metered; and second, any clogging or imperfect action of the regulator may put the entire amount through the meter, or, under other conditions, none through it, and the whole through the pipe without registering. This plan, as yet, has met with little favor, and may be said to have scarcely gone beyond the experimental stage. Its entirely inferential character and great delicacy renders it a little more than a guessing machine.

A number of devices such as tilting tanks, floats and weighing wheels are simple and effective where they can be used for delivering water without pressure, into a tank, but, of course, are entirely unavailable for the market, as the introduction of a meter on a pipe must not reduce or affect the pressure.

A positive displacement rotary, in distinction from the turbine or screw wheel type, has constantly been sought for as the solution of an efficient low-priced meter. The same observation applies here as in the reciprocating piston. Almost any reasonable, well-constructed rotary piston will measure water if not overcrowded, but with few exceptions they would have to be made so large as to be unavailable, or, if reduced in size, are sure to introduce the same defects as noted in the reciprocating meter. Friction and consequent wear and inaccuracy has been an almost unsurmountable obstacle in the path of a small piston rotary. Until within a few years the only device of this kind meeting with any degree of success has been the double piston rotary, and this at the expense of delicate and costly workmanship. The style referred to is on the same general principle as the douuble-gear piston found in several patterns of steam engine pumps and blowers.

A step of great importance has been taken in the combination of a casing and one piston in such a manner that the piston may move within its case dependent upon no journals or bearings. The effect of this is so far to reduce friction and increase operative areas as to bring the meter within a very small compass. Were it not not one fault, one which is singularly developed as a special defect, the liability to stop by the wedging of a minute particle of sediment between one of the many contact surfaces offered by their peculiar design this improvement would have proved the meter ultimatum. The introduction of this class of meters in western and other cities, where river water is used, and in many other places where the water contains a large amount of sediment, has necessarily been limited.

There has been a special effort towards the designing of a meter which shall remove the defects of uncertainty and unreliabiilty so long characteristic of all rotaries without sacrificing any of the advantages obtained by the use of a non-rotating piston. This end is accomplished in a class of meters in which the piston is perfectly free and loose in its case. It is confined in its path only by the pressure of the water in distinction to all others which divide the case in such a manner that the piston is held in a rigid mechanical path. This feature enables the piston to ride over substances which would lock any rotary whose piston is mechanically confined or rut and wear out any reciprocating meter.

There is developed in all modification of this class a self compensating feature by which a seeming paradox is actually accomplished, the fit of the parts is improved by use. A small excess of pressure on one side of the piston serves to maintain its contact on the other, giving by continued service a fit superior to the best mechanical grinding. Acting as its own valve, it is perfectly balanced by the duplicate porting of the plates between which it runs. Too much importance cannot be attached to balancing the moving parts especially in a high-speed meter, using the expression in the same way it would be applied to an engine.

The lifetime of a meter is determined by the wear of its parts, which in turn depends upon the friction. Tight fitting is to be discouraged, as it is productive of friction and inaccuracy. It is evident that in order to reduce a meter to the size required by a marketable price, the working parts must move with great rapidity. That is to say, if it is desired that a very small part do the work of a large one, it must of course move very fast. This means the use of a revolving piston in preference to a reciprocating. It is obviously impossible for a reciprocating piston to attain the speed in a non-elastic fluid that a continuous motion or revolving piston is able to reach. In view of this, it is thought that this rule will apply. All moving parts in a high-speed meter must be either balanced in action or compensating for wear. In the style of meter last referred to this rule is applied to a marked degree. The principle involved is susceptible of many modifications. An illustration is found in a meter in which the piston—which is made of hard rubber on account of its lightness and great durability—moves in a circular path, but does not in any sense rotate on an axis real or imaginary. It has six radial projections, which in turn enter six measuring spaces or recesses in the casing, which is also of hard rubber, and by dividing each into receiving and discharging spaces operates upon precisely the same principle as piston and cylinder displacement. Three of the six projections are at work in their respective recesses at a time, and the same relative side of each being, by the arrangement of the ports, open to the inlet, and the other side to the outlet, a continuous motion and flow is effected. At the same instant that one projection leaves its space another one on the opposite side commences to work. The piston carries a pin which drives a registering train, and as a certain uniform amount is discharged per revolution, proper gearing reduces it to cubic feet, the unit of measurement. It is believed that the improvement of a "free piston" so far reduces internal friction as to materially increase the efficiency of the rotary meter, the consequent gain in durability more nearly approaches the requirements of cost.

34th Annual Meeting of the American Society of Civil Engineers.

The Thirty-fourth Annual Meeting of the American Society of Civil Engineers will be held at their house in this city, commencing on January 19, 1887, at 10 o'clock.

The usual annual reports will be presented, officers for the ensuing year elected and time and place fixed for the next Annual Convention. Arrangements are being perfected by a committee for visits to points of interest.

List of New Water-Works.

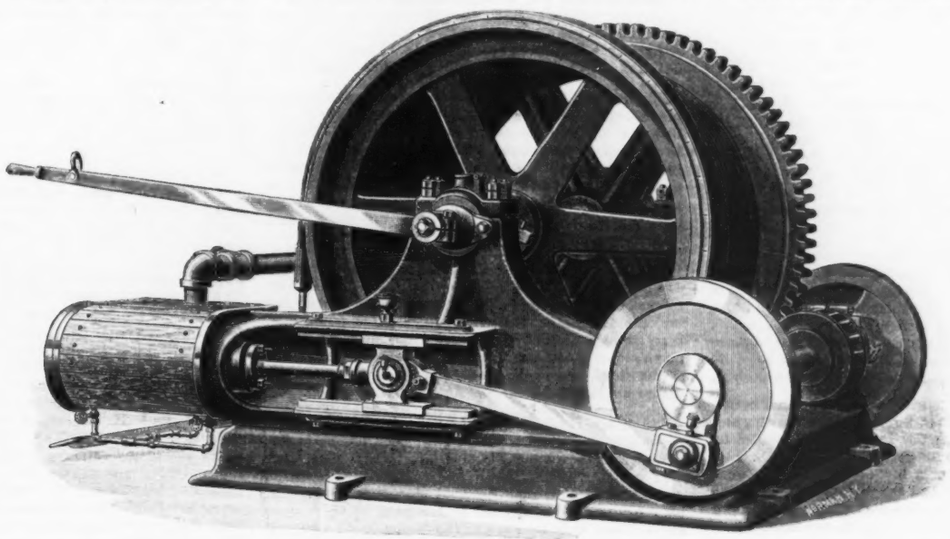
Projected or completed, or extensions, mentioned in ENGINEERING NEWS, December 18th and 25th, (see page 412):

Austin, Tex.; Pittsburg, Pa.; Pittsfield, Mass.; Clinton, Mo.; Tarentum, Pa.; Washington, D. C.; Philadelphia, Pa,; Cleveland, O.; Lebanon, Pa.; Memphis, Tenn.; Albion, Neb.; Meridian, Miss.; Middletown, Conn.; Bath, N. Y.; Streator, Ill.; Columbia, Tenn.; Columbus, Neb.; Livermore Falls, Me.; Argentine, Kan.; Keene, N. H.; Camden, N. Y.; Ashland, Ky.; Pleasant Hill, Mo.; Wabash, Ind.; Freeport, Ill.; Jersey City, N. J.; Hiawatha, Kan.; Lyons, N. Y.; Mobile, Ala.; Pensacola, Fla.; East Greenwich, R. I.; Mansfield, Mass.; Annapolis, Md.; Bath, N. Y.; Colorado Springs, Col.; Richmond, Va.; Bridgewater, Mass.; Hagerstown, Md,; Nebraska City, Neb.; Montclair, N. J.; Braintree, Mass.; Beverly, Mass.; East St. Louis, Ill.; Cohasset, Mass.; Racine, Wis.; Louisiana, Mo.; Davenport, Ia.; Newport, Ark.; Trenton, Mo.; Augusta, Me.; Garden City, Kan.; Camden, N. Y.. St. Louis, Mo.; Framingham, Mass.; Indianapolis, Ind.; Minneapolis, Minn.; Clyde, Kan.

The Bacon Double Cylinder Winding Engine.

The past few years have been remarkable for the very extensive development of mines in many parts of our country, but especially in the South and on the shores of Lake Superior. The annual output has been increased by hundreds of thousands of tons, and as a consequence there has been a sharp demand for much more powerful and effective machinery.

The double cylinder winding engine illustrated herewith has been designed by the firm of Copeland & Bacon, of this city, to meet these requirements; and the machine combines all the points of excellence and practical efficiency that their long experience in the construction of mining machinery could suggest.



The Bacon Double Cylinder Winding Engine.

This engine is designed particularly for heavy lifts over a long distance, where a high rate of speed and great power are absolutely requisite for profitable working, and it is confidently recommended to purchasers for all such purpose. It is also especially adapted for the working of inclines, a type of engines which Messrs. Copeland & Bacon have made a most successful specialty. In many parts of the United States these engines are now daily hauling from 600 to 1,000 tons of ore, the greatest achievement being the lifting of from 1,000 to 2,000 tons of phosphate rock in every working day during the last year without the slightest stoppage, repair or inconvenience.

While power and speed are the prime qualifications of this engine, it is still simple in its mechanism. The engine hoists by an easy movement of the friction lever, which throws the drum into gear and retains it in position by a slight pressure of the hand or thigh; in lowering, the drum is thrown out of gear and rapidly overhauled by the weight of the skip or car, and is also constantly under perfect control by means of a powerful foot-brake. Steam is thus entirely dispensed with in lowering the load.

The engines, with different sized cylinders, are made with friction drums or link motion, single or double drums, to suit every possible demand of weight, speed, or location and dip of vein. In the design solidity, symmetry and finish are especially looked after; the other points are superior piston packing, massive connecting rod, aptly designed cross-head and strength of gearing. In short in these engines the workmanship and material are such as might be expected from the well-earned reputation of the makers.

A Color Indicating Changes of Temperature.

Mr. Henry Crookes, son of the celebrated Prof. Wm. Crookes, is said to have discovered a brilliant red color, which gradually becomes black as it is submitted to higher ranges of temperature. At 158° F. this color is absolutely black; but if allowed to cool it passes through its successive stages again, and regains its red color.

It can be submitted to these variations of temperature a great number of times without losing its peculiar properties. Its inventor, or discoverer, hopes to utilize it in indicating to the eye the condition of the journal-bearings of machinery.

WATER.

THE works of the Cincinnati & Newport Iron & Pipe Co., at Newport, Ky., were damaged by fire on December 10; the damage is not so great as was first reported and work in all departments will be resumed in about two weeks.

GARDEN CITY, KAN.—An election was held December 14th on the subject of issuing bonds for a system of water-works for fire and domestic use, and for the construction of a system of sewerage; the results were majorities of 178 and 219, respectively, in favor of the issue. Plans will be prepared at once by a competent hydraulic engineer and proposals for construction will then be called for. J. S. Humphrey, C. E., is the county surveyor.

THE HYATT WATER FILTER PATENTS.—Justice Bradley, of the U. S. Supreme Court, has sustained the John W. Hyatt patents for improvements in water filters, and owned by the Newark Filtering Co., in a suit brought against John E. Johnson, of Philadelphia, for infringement of patent. A perpetual injunction is issued against the Johnson party and a master has been appointed to assess the damages to the Newark Co., arising from the infringement of their patents.

CAMDEN, N. Y.—The proposed source of supply for the new water-works is Emmons brook, and the owners of mills and property along the brook have applied to obtain an injunction restraining the water commissioners from taking the water, as there is only sufficient now for mill purposes; or else to compel the commissioners to give full compensation.

ST. LOUIS, MO., WATER SUPPLY.—The recent cold weather has brought the Water-Works Department to face the very serious matter of a shortage in the water supply. For the five days ending December 2nd, with two high service engines at work, there was a gain of 5,000,000 gallons in the reservoir. With the same machines work during the five days ending December 7th, the consumption was 15,500,000 gallons more than was pumped showing an extra consumption of over 20,000,000 gallons in five days; over 4,000,000 gallons per day. The weather has now moderated to such an extent that if the seven men now employed in detecting waste give their entire attention to stopping the water takers from allowing the water to run to waste in cases where they have opened their faucets to prevent the water in the service-pipes from freezing, the major portion of this excessive waste can be stopped.

During the low water in the river and the coincident heavy draught upon the reservoir recently experienced, the reserve supply was reduced to a very small quantity, and the river was but a few inches above the pumping point. A continued fall for a short time longer would have created a water famine in the city, the consequences of which would have been very serious. The extraordinary wastage referred to produces evil results in which every water consumer in the city is interested, and an endeavor will be made to cut it short as much as possible. The same difficulty was experienced early in January, 1884, and was overcome only by very vigorous action on the part of the authorities. Mayor Ewing issued a proclamation to the citizens, calling upon them to stop all wastage, and the Water Department placed a large force of special water works detectors on duty. A thorough, rigid, "house to house" inspection was made. The number of houses thus examined was 125,193, in 10,187 of which wasting of water was found. These were notified to stop the wastage, and it was necessary to vigorously prosecute about 500 householders, and fine them in the Police Court, before the supply was adequate to the demand.

DEACON WATER WASTE PREVENTION SYSTEM.—Alexander R. Binnie, M. Inst. C. E., water-works engineer for Bradford, England, in October, 1884, introduced the Deacon waste prevention system into that city. In one district with 80,038 inhabitants and 40,643 taps, the total supply before this innovation was 22.47 gallons per head. After the Deacon inspection and repair the rate of supply was reduced to 14.35 per capita, with still some waste estimated at 5.5 gallons per head. The pressure in the latter case was high and constant and the supply unlimited. The cost of the work, including all expenses, was $18,275, and the saving effected in one year was equivalent to $63,995, or 472,602,000 gallons of water saved. In Carlisle, Gloucester, Portsmouth, Hereford, Hertford and Exeter the Deacon system has achieved almost equal results. In certain Lambeth districts of London the average consumption has been reduced from 35.09 to 15.28 gallons per head in the same way under constant supply. Mr. Binnie pertinently asks the question of English corporations why they will continue to supply 30 to 40 gallons per head per day under the intermittent system when they can give a constant supply and save water, by simply repressing waste.

MEMPHIS, TENN.—The legislative council has adopted the report of the Water Committee and the City Attorney has been instructed to prepare the necessary bills for legislative action to empower the city to build its works at once. The supply is to be drawn from Wolf river, twelve miles above the city. The cost will be about $1,000,000. The revenue derived from consumers, who will be supplied with filtered water, guarantees a sum over the expenses of running the works. The present supply is furnished by the Memphis Water Co., whose plant was recently sold to Samuel R. Bullock & Co., of New York City, for $350,000.

GENESEO, N. Y.—On December 20th it was voted by a majority of 287 to 33 to appropriate $50,00 for a water upply from Conesus lake

LENOX, MASS.—The water company will increase its capital stock, build a new reservoir of larger capacity than the present one, and lay larger mains. It will also supply Stockbridge.

NEW ORLEANS, LA.—D. A. Compton, of Hawley, Pa., has written to ask the mayor what the city would pay him for a drainage system that would answer all the requirements of the city; he claims to be the inventor of a practicable and efficient system.

BRUNSWICK, GA.—A vote is to be taken on January 8th for empowering the municipal government to issue $150,000 bonds; $60,000 to take up the outstanding bonds $10,000 to find the floating debt and the remainder to be expended on a system of sewerage.

FRAMINGHAM, MASS.—Various plans for improving the sewerage system are under discussion, including the scheme to take the sewage to the sea; the town to build a sewer, and all persons to pay for using it, as is done at Boston. The plan submitted by the drainage commission to the last Legislature is thought by many to be desirable.

MINNEAPOLIS, MINN.—The city has about 80 miles of water mains. During the year over 26 miles of mains have been laid, and 396 hydrants and 212 gates put in Next year 36 miles are to be laid, a large proportion will be of large size. The daily consumption is 15,000,000 gallons. There is thought to be a serious leak in one of the submerged pipes in the river and an inspection is to be made.

CLYDE, KAN.—New water-works are being put in; the supply is taken from wells and pumped into a stand-pipe. Two pumping engines are being put it, a duplex one for fire purposes, with a capacity of 625,000 gallons per day, and a single one for domestic purposes, with a capacity of 300,000 gallons per day. When finished there will be six miles of pipe, 40 fire plugs and over 100 private hydrants. The works will cost $30,000 complete.

GOOD WORK.—Supplementing our note under this head on page 393, Mr. C. D. Barstow, of the Water and Gas Works Construction Co., Pittsburg, Pa., writes us that in building the water-works at Mattoon, Ill., 2,447 joints of pipe, from 4 to 12 inches in diameter, were made during September and October, 1885. The mains were all tested under a pressure of 180 pounds, and though the works have now been in operation for a year, neither leak nor break has occurred.

WATER COMPANIES.—The Aiken Water Supply & Gas Co., of Aiken, S. C., has been incorporated by John W. Baum, F. B. Henderson, D. S. Henderson, John Staubs and Henry Busch. The minimum capital is $2,500, and maximum $50,000.

The American Water Supply Co., of Kenasha, Wis., has been incorporated by J. H. Howe, H. B. Hinsdale and E. Simmons. Capital stock, $90,000

The Bridgewater Water Co., of Bridgewater, Mass, has been incorporated by Benjamin C. Mudge, Louis C. Johnson, and Orson G. Stanley.

Water-works companies have been incorporated at Greensburg, Kan., capital stock $50,000; Florence, Ala., $50,000; and Greenville, S. C., $100,000.

INDIANAPOLIS, IND.—The water-works company has declined to accept the terms offered by the Council, viz.—a three years contract at $45 per fire plug and free supply to the drinking fountains. The company asserts that no money can be made on such terms; the original arrangement with $50 per plug and drinking fountains charged for did not allow of a profit sufficient to pay a 1 per cent. dividend; and the company wants a five years contract on the old terms. It is also proposed to reduce the required number of feet of pipe to be laid each year to 5,000 feet, with a fire plug to each 1,000 feet instead of 500 feet. No decision has been reached and the whole affair may be submitted to a board of arbitration.

WATER FOR JERSEY TOWNS.—John R. Bartlett, of New York City, has made a proposition to supply water to Newark, N. J., and includes Jersey City and New York City in his scheme. Through an agent he has been purchasing farms, lakes and woodland in counties around Newark. Macopin pond, near Charlotteburg, and a reservoir of 600 acres area, with an average depth of 35 feet, to be formed at Dunker pond by building a dam 100 feet long and 50 feet high, form the main supply for the system projected by a syndicate formed by Mr. Bartlett. In addition, however, the projectors have secured the natural overflow of several lakes and ponds, and have purchased land at Oak Ridge, Montville and elsewhere for reservoirs, and at Great Notch, in the Orange mountains, for the great high service reservoir to supply the cities east of the mountains. Mr. Bartlett is building ice houses and also a railroad to connect with the Delaware, Lackawanna & Western R. R. George F. Baker, President of the First National Bank, of New York, is interested.

RED CLIFF, COL.—Two propositions have been made to put in water-works. One from parties connected with the Colorado Midland R. R. Co., and the other from J. H. Ferguson, representing New York parties.

CHILLICOTHE, MO.—The proposition to grant a water and gas works franchise was passed December 18th by a vote of 664 to 8. A $90,000 plant will be put in and work is to be commenced at once; 50 tons of pipe have been delivered; the stand-pipe will be 150 feet high.

CHARLESTON, Ill.—It has been rumored that the water supply was failing, and that the water-works would have to shut down. This is indignantly denied as a "malicious canard." Several mills and factories are using the water supply for power, and the supply is now, and has been plentiful, since the water-works were put in, in 1876.

BROCKTON, MASS.—The plan of Mr. Phineas Ball, C. E., of Worcester, for sewage disposal has been accepted. Pumps will force the sewage to the "muster field," and will be distributed on the surface. The cost of the mains and pumping station will be $67,000; preparing 100 a res, $4,000; pumping 1,000,000 gallons per day, $2,000 per annum. A loan of $2,000 will be raised.

THE NEWARK STEAM HEATING & POWER CO. has been incorporated at Newark, N. J., by John H. Hapwood Robert R. Zelt and others. Two large factory buildings have been purchased, and a large boiler house will be erected, to contain boilers with an aggregate of 100,000 H. P. Steam will be supplied for heating, cooking and power purposes, etc., as in New York City. Work will be commenced on pipe laying early in the spring, and it is expected to supply steam by March 1st.

DRAINAGE DITCH.—The preliminary survey of a big drainage ditch, 40 miles long, has been made near Pueblo, Col., from the St. Charles river where it empties into the Arkansas. The ditch runs east 40 miles, and is an average distance of 12 miles from the river on the north side. It is calculated to irrigate 12 miles on either side. The project is backed by an eastern syndicate, and work will be commenced in the spring.

KANKAKEE, ILL.—The plans for the new stand pipe, to replace the one blown down, have been finished; the tower will be 116 feet high, 20 feet in diameter, and will rest on a foundation 40 feet in diameter; the upper rings will be of ¼-inch, instead of ⅛-inch, iron. Six plate braces will be fastened at the base of the tower and six iron rods attached to the tower at a height of 12 feet will anchor it to the foundation. The water company (H. C. Hodgkins, President) has completed, the works so far as to be able to give fire protection and proposes to operate them on the direct pressure system until their completion; a pressure of 50 pounds to be maintained in the pipes. The city has accepted the proposition and will pay $250 per month from January until the works are completed. This temporary acceptance not to be construed as a final acceptance of the works or to invalidate the present contract.

CRAWFORDSVILLE, IND.—The works were publicly tested on December 18th and the results were entirely satisfactory. The contract was made by the City Council with the Crawfordsville Water-Works Co. in November, 1885, and the contract for construction was let to Messrs. Comegys & Lewis, of New York City, last spring. The system is on the stand-pipe and direct pressure plan; the stand-pipe is 175 feet high and there are 12 miles of mains, 125 hydrants and six drinking fountains; there are three pumping engines, one with a capacity of 1,000,000 gallons per day and the other two with a capacity of 1,500,000 gallons each. Col. S. H. Lockett was the engineer in charge. The city will pay $5,000 per annum; the company is composed of John S. Brown and R. B. F. Pierce, of Crawfordville, and E. B. Martindale, of Indianapolis. The franchise is for 20 years.

STREET CLEANING.—The City Engineer of Rochester, N. Y., in his report for the year 1886, states as follows:

"In our own country the most recent and most careful comparison of the relative costs of sweeping paved streets by hand and by machine was instituted last year by L. W. Rundlett, city engineer of St. Paul, Minn. From May 11, to August 1, 1885, all work of sweeping the paved roadways of that city was done by hand, the maximum of the cost per mile being at first about $30, and then gradually falling to a minimum of $18.50, as the men became more accustomed to the labor and were better organized. This latter price the engineer believes to be the lowest average of cost of sweeping, which it is possible to attain by manual labor and with wages at $1.50 per day of ten hours. The work was performed regularly by the same corps of men under careful supervision, and over a large territory, so that advantage was taken of acquired experience. The results achieved during the period mentioned were 166.07 miles of paved streets swept by hand at a total cost of $3,470.75, thus giving an average cost of $20.90 per mile including the removal of the dust.

Meanwhile the city had purchased a two-horse sweeping machine for $500, which was set to work on August 1, 1885, and continued in operation night and day, sweeping about 85,000 square yards of pavement every twenty-four hours, the average performance at this rate being 3,542 square yards per hour. The actual cost of the work, including removal of sweepings, ranged from $10.37 to $8.48 per mile, with an average cost of $9.18 per mile, as deduced from a total length of 39.25 miles of street swept at an aggregate expense of $360.37. It should be mentioned that these figures do not include the cost of any ash or domestic rubbish removal, and also that the paved streets of St. Paul are reported to be in excellent order, many of the pavements being quite new or at least of very recent date. It will thus be seen that with suitable sweeping machines the expense of the frequent cleaning of city streets can be considerably reduced.

IN EUROPE the cost of mechanical sweeping is estimated at about one-third of that resulting from the employment of hand work, while in St. Paul it has just been demonstrated that machine sweeping can be done for about one-half of the cost of manual labor. In considering the performance of such machines, however, we must not lose sight of the fact that they are serviceable and economical when applied at comparatively frequent intervals to the same street area, since they cannot deal successfully with thick layers of tenacious mud.

NEW WATER-WORKS.—Hiawatha, Kan. Surveys and plans have been made and $50,000 bonds are to be issued.—Lyons, N. Y. The new works will be completed shortly, an iron stand-pipe with a capacity of 180,000 gallons, is being erected: the cost will be about $74,000.—Mobile, Ala. The work of the Bienville Water Supply Co. is being pushed rapidly.—Pensacola, Fla. The Pensacola Water Co. will extend its mains to the terminus of the Pensacola & Perdido R. R., one mile from the city.—East Greenwich, R. I. The water system has been put in operation; there is a high pressure, duplex pumping engine at Hart's river, with a capacity of 2,000,000 gallons per day; and two Worthington pumps at the well; there is a stand-pipe and ten miles of pipes; H. K. Jackson superintended the construction.—Mansfield, Mass. The citizens who favor water-works and obtained a charter, will call another town meeting and expect to have enough votes; they have been twice defeated.—Annapolis, Md. A contract for an artesian well to supply 10,000 gallons daily has been awarded to John W. Craig, for $150.—Bath, N. Y. The trustees have accepted the offer of Bassett Bros., of Buffalo, for constructing a system of water-works; the works to be owned by a private company and the village to pay $2,400 per annum for 71 fire hydrants.—Colorado Springs, Col. The City Council has authorized the Water Committee to construct a new reservoir, the city engineer will have charge.—Richmond, Va. A water tower is to be erected to give increased pressure.—Bridgewater, Mass The plan for a water supply having been rejected, other plans are now being discussed: the East Bridgewater Improvement Association favors a joint supply for the two towns.—Hagerstown, Md. The Washington County Water Co. has awarded a contract to Huron A. Heyett for sinking an artesian well at Cavetown.—Nebraska City, Neb. Work has been commenced on the pipe laying; the works are to be completed by July 1.—Montclair, N. J. Frederick M. Wheeler, representing a Boston company, has submitted a proposition to put in water-works.—Braintree, Mass. A committee has been appointed to consider the question of contracting with the Braintree Water Supply Co. for 100 hydrants for $4,000 per annum and $35 for each additional hydrant; a reservoir with a capacity of 325,000 gallons will be built and mains laid.—Beverly, Mass. The new water supply system will be completed shortly, but will not be put in operation before the spring.—East St. Louis, Ill. The new works have two Worthington engines, pumping 4,000,000 gallons per day; the consumption exceeds 1,000,000 gallons per day.—Cohasset, Mass.—The new works have been put in operation, there are 65 driven wells, a pump with a capacity of 750,000 gallons, and a reservoir. Over five miles of pipe have been laid.—Racine, Wis. The city is considering whether to make connection with the unfinished works for fire protection during the winter or to wait till their completion in the spring.—Louisiana, Mo. Work has been commenced by Bronson & Foster, of New York City; there will be six miles of pipe and 41 hydrants.—Davenport, Ia. The water company has contracted with H. R. Worthington for a 6,000,000 gallons capacity pumping engine, to cost $30,000.—Newport, Ark. Fairbanks & Co., of St. Louis, are putting in a reservoir and pumping machinery.—Trenton, Mo. The works have been tested and accepted, the town pays $3,000 per annum for 50 hydrants.—Augusta, Me. A new reservoir will be built at the water-works.—Carlyle, Ill. Address T. E. Ford.—Fairbury, Ill. Address L. B. Downing, T. S. McDowell.—Bennington, Vt.—Bellevue, Ky.—Lebanon, Tenn.—Victoria, Tex.—Greenwich, N. Y.—Farmington Falls, Me.—Joliet, Ill.—Paris, Tex.—Bridgeport, Mass.

NEWS OF THE WEEK.

Contracting.

Bulkhead.—The following proposals were received at the office of the City Engineer, Boston, Mass., for constructing a wooden bulkhead at Beacon street: Benjamin Young, $3,167; J. T. Scully, $3,349; J. N. Hayes & Co., $3,431.74; Josiah Shaw, $3,450; W. A. Kendrick & Sons, $3,499.

Pipe Works.—Shickle, Harrison & Howard Iron Co., of St. Louis, Mo., will erect extensive works for the manufacture of cast-iron pipe at Philadelphia, Pa.

At South Pittsburg, Tenn., a company has been organized to build pipe works. President, G. E. Downing; Secretary, W. R. Townsend. Capital stock, $50,000.

Excavation.—The following proposals have been received by Lieut. Col. O. M. Poe, U. S. Engineer Office, Detroit, Mich., for excavating at Middle Neebish, Hay Lake channel, Michigan: Hickler & Green, Sault Ste. Marie, Mich., $1.95 per cubic yard in bank; Carkin, Stickney & Cram, East Saginaw, Mich., $2.65; L. P. & J. A. Smith, Cleveland, O., $3; Charles S. Barker, Duluth, Minn., $3.80; Williams, Upham & Co., Duluth, Minn., $4.30.

Lumber, Stone, Etc.—The following contracts have been awarded for constructing a keeper's dwelling at the Mosquito inlet lighthouse station, Florida; Lumber, Wilson Hunting, Baltimore, Md., pine, $28 per 1,000 feet; cypress shingles, $6 per 1,000; lath, $3.50 per 1,000. Stone, M. Gault & Son, Baltimore, Md., $271.14. Plaster, Wirt, Clarke & Son, Baltimore, Md., $100. Paint and oils, James Lucas & Co., Philadelphia, Pa., $171.78. Copper and tin, John G. Hetzell & Son, Baltimore, Md., $200.70.

Dredging.—The following proposals have been received by Capt. James B. Quinn, U. S. Engineer Office, Duluth, Minn., for dredging in St. Louis and Superior bays, Wisconsin; and at Grand Marais harbor, Minnesota, respectively: Truman & Cooper, Manitowoc, Wis., 22 and 33 cents per cubic yard; Chicago Dredging & Dock Co., Chicago, Ill., 25 and 35 cents; Green Bay Dredge and Pile Driver Co., Green Bay, Wis., 19.5 and 29 cents. Renseler R. Dodge, Fulton, N. Y., 19 and 39 cents; Charles S. Barker, Duluth, Minn., 18 and 30 cents; Williams, Upham & Co., Duluth, Minn., 19.5 and 24.75 cents.

The following proposals were opened December 18 by Lieut. Col. D. C. Houston, U. S. Engineer Office, New York City, for dredging in Stamford harbor, Conn.: Hartford Dredging Co., 15.7 cents per entire yard; total, $7,850. Frank Pidgeon Dredging Co., 17.9 cents, $8,950. Richard M. Payn, 18 cents, $9,000. Richard Parrott, Newburg, N. Y., 21 cents, $10,500. John McDermott, 23¾ $11,937.50. Charles DuBois & Henry DuBois, 25 cents, $12,500. W. H. Beard, 28.5 cents, $14,250.

Heating Apparatus.—The following proposals have been received at the office of the Supervising Architect, Treasury Department, Washington, D. C., for steam heating apparatus for the public buildings at Quincy, Ill., and Jefferson City, Mo., respectively: Stafford Ventilating Co., New York City, $38,020, $29,839; Walworth Manufacturing Co., Boston, Mass., $10,052, $3,914; West Point Engine & Machine Co., West Point, Pa., $5,869, $5,425; Exhaustive Ventilating Co., Chicago, Ill., $9,964, $10,380; St. Louis Steam Heating & Ventilating Co., St. Louis, Mo., $8,151, $6,314; Keeley & Co., Cotumbus, O., $11,665, $8,869; Samuel Pope & Co., Chicago, Ill., $9,890, $9,375; Diedrich & Hoges, Chicago, Ill., $12,370, no bid; W. K. Irkup & Sons, no bid, $7,949.

River and Canal Improvement.—The following bids have been received by Lieut. Col. O. M. Poe, U. S. Engineer Office, Detroit, Mich., for improving St. Mary's river and St. Mary's Falls Canal. 1. Furnishing dredge, tug and two dump scows: Hickler & Green, Sault Ste. Marie, Mich., $9, $10, and $11 per hour; Carkin, Stickney & Cram, East Saginaw, Mich., $11.50; Charles S. Barker, Duluth, Minn., $15.

2. Lumber for bulkhead, piers and coffer dam; Chauncey E. Mitchell, Ludington, Mich., white pine $17 per 1,000 feet B.M.; hemlock, Norway or white pine, $13; white pine joist and plank, $16; hemlock, Norway or white pine plank, $10; total $38,547.48. Carkin, Stickney & Cram, East Saginaw, Mich., $22, $17.50, $20, $16; $50,703.21. John W. McGinn, Cheboygan, Mich., $25, $18, $20, $14; $53,415.20. John G. Owen, East Saginaw, Mich., $30, $20, $24, $16; $61,180.56. Charles S. Barker, Duluth, Minn., $24, $24, $20, $20; $64,219.05.

3. Iron Bolts and Spikes: Ducharme, Fletcher & Co., Detroit, Mich., blunt bolts, 2.6 cents per pound; boat spikes, 2.7 cents per pound; total $4,902. Mark Packard, Buffalo, N. Y., 2.79, 2.6 cents; $5,211.60. Luther E. Allen, Charlevoix, Mich., 2.8, 5.25 cents; $5,607. Hickler & Green, Sault Ste. Marie, Mich., 3.25, 4.25 cents; $6,250. Charles S. Barker, Duluth, Minn., 3.5, 3.5 cents; $6,580 Carkin, Stickney & Cram, East Saginaw, Mich., 3.5, 4.5 cents; $6,730. Morley Bros., East Saginaw, Mich., 4, 3.2 cents, $7,408. Chicago Forge & Bolt Co., Chicago, Ill., 2.75 cents, no bid.

4. Framing, placing & filling crib piers, Chauncey E. Mitchell, Ludington, Mich., white pine timber and plank, 6 cents per cub. ft.; hemlock or Norway pine timber and plank, 6.5 cents per cub. ft.; stone filling, 37 cents per cubic yard; total, $20,725. Carkin, Stickney & Cram, East Saginaw, Mich., 6.5, 6.5, 50 cents; $24,200. Demond & Lipsitt, Sault Ste. Marie, Mich., 8, 8.5, 40 cents, $25,075. H. J. Dupuis, Detroit, Mich., 7.5, 7.5, 52 cents; $26,500. Hickler & Green, Sault Ste. Marie, Mich., 7.75, 7.75, 60 cents; $28,950. Schwarz & Berner, Green Bay, Wis., 8, 8, 63 cents; $30,150. Charles S. Barker, Duluth, Minn., 8, 8, 65 cents; $30,650. Lorenzo D. Jenne, Sault Ste. Marie, Mich., 9, 9, 70 cents; $33,700. Luther E. Allen, Charlevoix, Mich., 10.8, 10.8, 91-25 cents; $42,252.50.

5. Puddling clay for coffer dam, Carkin, Stickney & Cram, East Saginaw, Mich., clay deposited in dredge cut or trench, 56 cents per cubic yard; clay deposited between piers of dam, 56 cents per cubic yard; total, $18,480. Hickler & Green, Sault Ste. Marie, Mich., 65, 70 cents; $22,100. Charles S. Barker, Duluth, Minn., 80, 80 cents, $26,400.

Dam.—The Scranton (Pa.) Gas and Water Co. has awarded the contract for a dam on Oak run, a mile above Dunning, to Burke Bros. The dam will be 45 feet high and the reservoir will have a capacity of 400,000,000 gallons.

Boiler.—The following proposals were opened December 18 by Major W. H. Heuer, U. S. Engineer Office, New Orleans, La., for a new boiler for the U. S. lighthouse tender "*Arbutus*": Columbia Iron Works & Dry Dock Co., Baltimore, Md., $5,285; Edward J. Codd, Baltimore, Md., $61,95; Whitney Iron Works Co., New Orleans, La., $6,500.

Pipe.—The following bids were opened December 18 by the Water Commissioners, Albany, N. Y., for 6,500 feet of 12-inch and 7,000 feet of 6-inch: Florence Iron Works, Philadelphia, Pa., 12-inch pipe, $31.50 per ton; 6-inch pipe, $33 per ton; specials, 3 cents per pound. Warren Foundry & Manufacturing Co., Phillipsburg, N. J., $32, $32.30. McNeal Pipe Foundry, Burlington, N. J., $33.75, $34.25.

The Block Pavement Co. has been incorporated at Camden, N. J., by Charles L. Zane, Jacob C. Dural and George L. Carsons. Capital stock, $100,000.

Coping Stone.—The contract for the coping stone for the river wall has been awarded by the Philadelphia Park Commission to James Sillery at $3.74 per foot.

Gas Lamps.—At Brooklyn, N. Y., the contract for gas lamps has been awarded to the Nassau Gas Lamp Co. at $25 each.

Gravel.—The contract for gravel to replace a worn-out Nicholson pavement at Vicksburg, Miss., has been awarded to Messrs. Mattingly & Gunning, at $1.30 per yard.

Asphalt Paving.—The contract for asphalt paving for the Park Commission, Philadelphia, Pa., has been awarded to the Vulcanite Paving Co. at $1 55 per square yard; and for asphaltum blocks to the Trinidad Asphaltum Block Co. at $65 per 1,000.

Paving.—The following proposals were opened December 17 at the Department of City Works, Brooklyn, N. Y., for grading and cobblestone paving on Ralph street: Henry A. Nolan, $3.45 per lineal foot; Daniel J. Creem, $3.97; Thomas McDonald, $4.13; John Maguire, $4.30.

Testing Bridge Material.—The Pittsburg Testing Laboratory has secured the contract for testing the material to be used in the Poughkeepsie bridge. Mr. Alfred E. Hunt, the head of the firm, reports that they have over 18,000 tons of material now on hand at various points for testing.

Life-Saving Station.—The following proposals for improvements to the life-saving station at Erie, Pa., have been received by the Superintendent of the U. S. Life-Saving Service, Treasury Department, Washington, D. C.: Constable Bros., Erie, Pa., $3,300; Francis H Smith, New York City, $4,444.

Street Work.—The following proposals were opened December 21st by the City Commissioner, Baltimore, Md., for grading, paving and curbing: Patrick Reddington, grading, 35 cents per cubic yard; curbing, 40 cents per lineal foot; paving, 5.5 cents per square foot. W. E. Anderson, 47, 40 and 5.5 cents. James P. McGovern, 37.5, 45, and 6 cents. A. Schneider & Son, 40, 40 and 6 cents.

Sheet Iron.—The following proposals were opened December 21st at the Office of Building for State, War and Navy Departments, Washington, D. C.: West Point Engine & Machine Co., $823; Bartlett, Hayward & Co., Baltimore, Md., $1,148; Stockstill & Co., Washington, $1,200; Otto L. Wolfsteiner, Washington, $1,287.50.

Sewers.—The following proposals were opened December 17th at the Department of City Works, Brooklyn, N. Y.: John Bray, 15-inch cement pipe, $1.20 per foot; 12-inch cement pipe, 95 cents; manholes, $33 complete with iron head and cover. Daniel J. Creem, $1.15, 88 cents, $35. John S. Bogert, $1.15, 85 cents, $35. Edward Gorman, $1.14, 86 cents, $33.75.

The following proposals have been received by the Surveys Department, Philadelphia, Pa., for 2,300 feet of the intercepting sewer at Manayunk; B. E. Malone, two-ring brick sewer, 3.5 feet diameter, $18.50 per foot; three-ring sewer, $19.75 per foot; cast-iron sewer pipe, 3.5 feet diameter, $19.75 per foot. James Deehan, $18, $18, $18. James Sullivan, $16.85, $17.85, $17.85. M. C. Hong, $21, $18, $18.

Railroad Contracts.—Messrs. Putnam & Tobias have the contract for the Mobile & Alabama Western R. R., and are at work on the section from Mobile to Jackson, Ala.

Messrs. Antonelli & Tench, of Chicago, have the contract for grading and timber work on the Duluth, South Shore & Atlantic R. R. from Sault Ste. Marie to Waiska Bay. The trestling will be built during the winter and the line is to be completed in July. The contractors' headquarters are at Sault Ste. Marie, Mich.

Messrs. J. D. Gonder & Bros., Strasburg, Pa., have the contract for the grading, masonry and ballasting of four sections of the Cincinnati & Richmond R. R.; the line is in the interest of the Pennsylvania R. R.

The Panhandle Construction Co. has the contract for the extension of the Fort Worth & Denver R. R., 200 miles. Gen. G. M. Dodge, Forth Worth, Tex. is president of the construction company.

The contracts for the Louisville Southern R. R. have been awarded as follows: Sections 1 to 12, Cavanaugh & Crow; 12 to 17, Patterson & James; 17 to 22, Green & McMahon; 22 to 28, Haze & Sullivan; 28 to 38, C. R. Mason & Co. The Lawrenceburg division has been awarded to Montgomery Bros.

The U. S. Railroad Construction Co. has the contract for building the Savannah, Dublin & Western Short Line R. R.; Gen. Van Fassen is president of the construction company.

The winter headquarters of the contractors and engineers of the Toledo, Saginaw & Muskegon R. R. have been established at Greenville, Mich.

Bridge Foundations.—W. G. Coolidge & Co. have been awarded the contract for building and sinking the pneumatic caisson, 114 feet x 20 feet, for the center pier of the steel arch bridge across the Mississippi river at Minneapolis, Minn.

Bridges.—The following proposals were opened December 21st by the Chief Engineer and Survevor, Philadelphia, Pa., for the bridge on Glenwood avenue over the Philadelphia & Reading R. R.: Wm. H. H. Achuff, superstructure, wing-walls, railing, etc., complete, $10,800; additional rubble masonry, $6 per cubic yard; additional yellow pine, in place, $40 per 1,000 feet B. M.; embankment, in place, $28 per cubic yard. J. H. Hathaway, $13,393.71; $6; $42 50; $35. John M. Mack, $14,800; $5.90; $34.50; $30. The contract has been awarded to Wm. H. Achuff.

The contract for building the new iron bridge for the Chicago, Milwaukee & St. Paul R. R. at Third street, St. Paul, Minn., has been sub-let to the Keystone Bridge Co., of Pittsburg, Pa. It will cost $150,000. The new bridge at Kansas City, Mo., will take 2,000,000 pounds of steel.

Proposals Open.

Stone and Brick Work.—Estimates for the materials for the new shops. National Tube Works Co., McKeesport, Pa.

Street Paving.—Excavation, asphalt paving, granite flagging and blocks; and resetting old curbs. Board of Public Affairs, Cincinnati, O. December 28.

Steam Heating Apparatus.—Commissioner of Police and Excise, Municipal Building, Brooklyn, N. Y. December 29.

River Improvement.—Wing dams and shore protections in the Savannah river below Augusta, Ga. Col. Q. A. Gillmore, U. S. Engineer Office, Army Building, New York City. December 29.

Electrical Instruments.—Treasury Department, Washington, D. C. December 30.

Trestle.—Timber trestle over Morgan Run; length, 500 feet, average height, 500 feet. Plans at the office of the City Civil Engineer. Board of Improvements, Cleveland, O. January 3.

Stone, Brick and Iron.—Granite bond stones and bricks; for the public buildings. Office of the Commissioners of the Public Buildings, Penn square, Philadelphia, Pa. January 4.

Bonds.—$100,000 elevated roadway bonds, $17,000 sewer bonds. Office of the City Auditor, Cleveland, O. Jan. 8.

Lumber.—Long leaf southern pine, about 800,000 feet B. M., for flooring the Central Viaduct; sidewalk plank 7 feet 10 inches by 5 to 8 inches by 3 inches; roadway plank, 13 and 15 feet by 8 to 12 inches by 3.5 inches Board of Improvements, Cleveland, O. January 10.

Masonry.—Reservoir outlet and wing walls at the Potomac flats. Granite masonry, on a foundation of piles, grillage and concrete, built within a coffer dam; in about 6 feet of water. Lieut. Col. Peter C. Hains, U S. Engineer Office, 2136 Pennsylvania avenue, Washington, D. C. January 17.

Buildings.

Railroad Shops.—The Pennsylvania R. R. Co. has purchased ground at Camden, N. J., where it will erect machine and repair shops.

Depot.—At Pittsburg, Pa., an ordinance has been passed for the construction of the new depot of the Baltimore & Ohio R. R. on the Monongahela wharf.

Capitol.—The Illinois State Capitol at Springfield will be completed by January 1st. The structure, which is 354x250 feet, was commenced twenty years ago, and has cost the State $4,070,000.

Bank Building.—Contracts will soon be let for the building to be erected by the American bank, of Kansas City, Mo.: previously described in our columns. It will cost about $600,000. Burnham & Root, 42 Montauk block, Chicago, architects.

Office Buildings.—The New York Life Insurance Company will erect a very elaborate office building in Kansas City, Mo., the site having already been purchased. The structure will be ten stories in height and cost about $1,000,000.

Stores and Flats.—G. Edwards will erect two three-story cellar and attic, stores and flat buildings, 44x74 feet, at 1048-50, West Twelfth street Chicago; to cost $15,000. Exterior, pressed brick, stone, galvanized-iron, with store fronts of plate glass and iron.

William Engelbrecht will erect two three-story and basement store and flat buildings, 50x80 feet, 832-34 West Twenty-first street, to cost $25,000. Fronts of pressed brick, stone, galvanized-iron, plate glass and iron work.

Court House.—Architect J. C. Cochrane, 78 Ashland block, Chicago, has planned the new court-house for Carroll county, Ia., to be erected at Carroll. It will be two stories in height, 58x90 feet, of brick and stone; cost $60,000.

Depots.—The Pittsburg, Ft. Wayne & Chicago R. R. Co., has purchased a large tract of land on Anthony and Commercial avenues, South Chicago, Ill., and will erect an extensive freight and passenger depot, of brick and stone; to cost some $30,000.

The roof is being put on the superb new eleven-story office building—called the Rookery—corner Adams and La Salle streets, Chicago. This structure will cost about $1,500,000, and will be one of the finest office and bank buildings in the country. Burnham & Root, 42 Montauk block, Chicago, architects.

Public Hall.—A fine new public hall will be erected in Austin, Ill., for which a large amount of stock is being subscribed by the citizens of that enterprising suburb; $10,000 having already been raised. The building will be of pressed stone, interior decorations, etc. Fred R. Schock, 81 South Clark street, Chicago, architect.

Material Growth of Chicago.—There were 3,369 new buildings erected in Chicago during the past year, up to December 1st, with a total frontage of 108.551 feet; or twenty and one-half miles; and representing an outlay of $25,445,000. There were more buildings erected during the month of October, than any of the other months; 479 permits being issued.

Buildings.—Architect S. S. Beaman, 517 Pullman building, Chicago, is engaged on plans of a number of buildings, to be erected for Messrs. Proctor & Gamble, at their new town of Ivorydale, near Cincinnati, O.: there will be a warehouse, packing houses, boiler and engine house, and an office building 58x80 feet, two-stories, of pressed brick, stone, slate roof, etc. All of the buildings will be of brick and stone.

Schoolhouses.—Proposals will soon be invited by the city of Chicago, for supplying the following named new public school buildings, with furniture and fixtures: Walsh school, Twentieth and Johnson streets, to be completed February 1st, fifteen rooms. West Division high school, cost $150 000; on Congress, Lincoln, Honore streets and Ogden avenue, to be finished February 15th, twenty-four rooms. Augusta school, on Augusta street, Hoyne avenue, to be completed March 1st, fifteen rooms. Tilden school, cost $70,000; to be completed March 1st, fourteen rooms.

NEW YORK.

Mr. John P. Lee has designed for Michael L. White a four-story extension, 22x40, to be added to No. 169 East Eighty-eighth street.

Mr. Alexander I. Finkle has completed plans for two four-story brick and stone tenements, 25x80 each, to be built for Charles Downey on the north side of Houston street, 50 feet east of Cottage place to cost $40 000.

Mr. James Fettretch will build on the west side of Ninth avenue between Seventy-seventh and Seventy-eighth street, three five-story brick and stone flats with stores.

Mr. R. B. Eastman of the "Garfield" building, Brooklyn, is the architect for the alterations to be made to No. 30 Pierrepont street, Brooklyn, for Mrs. N. R. Eames, which will cost $30,000.

Mr. Wilbur S. Knowles reports plans on hand for a $6,000 cottage to be built at Tarrytown Heights for Mr. Burbank Roberts.

Railroads, Bridges and Canals.

The Panhandle Construction Co., of Des Moines, Ia., has been incorporated by G. M. Dodge, and others. Capital stock, $2,000.000.

The Congaree Construction Co., of Spartanburg, S. C., has been incorporated by D. R. Duncan, John B. Cleveland, John T. Slow and others, to build and operate railroads, etc. Capital stock, minimum, $20,000; maximum, $500.000.

Erie and Oswego Canals.—James Shanahan, Superintendent of Public Works, and Elnathan Sweet, N. Y. State Engineer, have been in Syracuse, N. Y., recently to superintend the commencement of the work of enarging the locks of the canals.

Union Elevated R. R. Co.—The Supreme Court has approved the report of the commission favoring all the routes, except route 8, for the Union Elevated R. R., Brooklyn, N. Y. The Department of City Works will be asked for a permit to open the streets with a view to commencing construction.

The Alaska Boundary.—Negociations are pending for the appointment of a joint commission by the United States and Canada to settle the boundary line between Alaska and British North America. The cost of such a commission, including the necessary surveys, would be about $4,000,000, to be borne jointly. Difficulties which are arising over possessions of large lumber and mining interests, render it necessary that some steps be taken without delay.

Locomotive Building in Australia.—The Phœnix Co., of Ballarat, has completed four of the fifteen heavy freight engines ordered last year by the Railroad Commissioners of Victoria. They gave entire satisfaction on their trial trips of 1,000 miles.

Dredging Through Ice.—It is said that Rittenhouse Moore, contractor for dredging the Potomac flats, at Washington, D. C., proposes to carry on his operations in spite of the ice; he will cut holes in order to dredge and haul the earth over the ice on sleds. River men say this will be impossible.

Steel Girders in Mines.—At a recent meeting of the Midland Institute (England) it was stated that experience proved steel girders to be far superior to timber for shoring up, etc., in mines. While the first cost was considerably greater, there were great advantages in point of durability, and safety, and they are of monetary value when taken out. The final economy is decidedly in favor of the steel.

Mexican Railroads.—The Mexican Central R. R. Co. has been authorized to organize separate companies for the construction of the Guadalajara and Tampico branches; the first line is intended to be completed by the end of 1887 and the latter by September, 1888.—The Mexican National R. R. Co. will start an engineer corps to locate the line from Saltillo to San Miguel de Allende —The International R. R. Co. is progressing rapidly with its line to Villa Lerdo and will reach its connection with the Mexican Central R. R. next year.

The Most Northern Railroad in the World.—Last November a railway was completed from Wasa to Uleaborg in Finland, a point lying in 65° North latitude, the highest point in the world reached by a railroad. The road is interesting in its peculiar features, in the region passed through the thermometer sometimes indicating 70° below the freezing point. The road is 270 miles long, standard guage, and cost $19,000 per mile as stated. It will ultimately connect the Russian railway system with that of Sweden and Norway.

The Severn Tunnel.—The tunnel under the river Severn, in England, on the Great Western R. R. Co's new short line from Bristol to South Wales, was opened for passenger traffic on December 1st. It has been used for freight traffic for several months. The ventilation is exceptionally good, and is managed by a Guibal fan, 40 feet in diameter and 12 feet wide, which makes 28 revolutions per minute and is capable of drawing 500,000 cubic feet per minute from the ventilating opening midway in the tunnel. The pumping machinery is said to be capable of lifting 25,000,000 gallons of water per day. The up and down tracks are on different levels at the southern approach, so as to provide an easy grade for the heavy coal trains for the South Wales coal fields. In the tunnel the tracks are on the same level, but approaching Bristol the north bound track rises rapidly to the surface, while the south bound track has an easier grade so that at the portals the roof of the tunnel of the latter track is about on a level with the floor of the other. The first passenger train passed through in 9.40 minutes and returned in 7.5 minutes; the fastest time yet made is 6.75 minutes. The tunnel is 4.25 miles long and was commenced in March, 1873. Its history and construction have been described in former volumes of our paper.

New Railroad Companies.—Iron Range Northern R. R. Co.; from the Iron Range R. R. to the Canadian Pacific R. R., with branches to the iron mines. A. H. Viele, H. F. Thompson, C. Tower, Duluth, Minn., and others.—Wellington, Anthony & Colorado R.R.Co.; N.D. Clark, O. F. Casteen, and others; headquarters at Anthony, Kan.; capital stock, $5,000,000.—Chicago, Santa Fé & California R. R. Co.; Norman Williams, Charles S. Holt, Chicago; capital stock, $30,000,000.—Duluth, Red Wing & Southern R. R. Co.; from Douglas county, Wis., to Red Wing, Minn.; 170 miles; capital stock, $1,500,000. —Cincinnati & Birmingham R. R. Co.; from the Cincinnati Southern R. R. in Kentucky, to Birmingham and the Gulf coast; M. R. Campbell, John C. Dougherty, W. Goodpasture; incorporated at Nashville, Tenn.—Utah Midland R. R. Co.: Governor West, Salt Lake City: capital stock, $5,000,000.—Kansas, Texas & Mexico R. R. Co.: from Kansas City through the Indian Territory into Mexico: H. Hale, Kansas City: C. W. Ament, Topeka, Kan., and others.—Indianapolis, St. Louis & Western R. R. Co.: President, Arthur Van Norman: Secretary, Adolph E. Dick, New York City.

St. Louis & Central Illinois R. R. Co.; from Springfield to Jersey Landing, Ill.; Hart A. Fisher, Delos R. Haynes, of St. Louis, and others; capital stock, $1,000,000.—New Jersey & Staten Island R. R. Co.; from Northfield, on the Arthur Kill, to Castleton, Kill von Kull, New York Bay, Edgewater, Concord, and Stapleton; John Moss, 197 Halsey street; James Hanall, 50 Berkeley place; Donald Mackenzie, 155 South Second street, all of Brooklyn, N. Y.—Mankato & Albert Lea R. R. Co.; from the Iowa north state line to the Minnesota north state line; John A. Willard, Mankato, Minn.; Wm. P. Sargeant, Albeart Lea, Minn.; capital stock, $1,000.000.—Georgia, Carolina & Northern R. R. Co.; Hoke Smith, Atlanta, Ga., and others.—Sioux City & Northeastern R. R. Co.; J. K. Graves, Dubuque, Ia., from Sioux City to Luverne.—Leroy & Eastern R. R. Co., Leroy, Ill.; John Dunn, Thomas E. Wing, and others; office at Chicago; capital stock, $15.000.—Baltimore, Memphis & Nashville R. R. Co., from Memphis, Tenn., to Bristol, 400 miles.—Kansas, Nebraska & Minnesota R. R. Co.; from Duluth, Minn., through Nebraska to Kansas; 120 miles; S. N. Wood, Strong City, Kan.; W. S. Smith, Garden City, Kan.; capital stock, $20,000,000; office at Larkin, Kan.—Gulf, Houston & Rio Grande R. R. Co.; from Houston, Tex., to Presidio del Norte, 635 miles.

Railroad Extensions in Colorado.—The Cheyenne & Northern R. R., from Douglas to Fort Fetterman, Wyo., will connect Denver with the Chicago & Northwestern R. R. The Chicago, Burlington & Quincy R. R. has graded a road in Cottonwood and Gore cañons to keep out other roads, it is not known whether a line will be built; a line is being built from Holdredge, Neb., to Akron, Col. The Chicago, Rock Island & Pacific R. R. Co. is stated to intend building to Denver, and is now building in Nebraska. The Colorado Midland R. R. is being pushed, it will extend from Colorado Springs to Leadville and the junction of Frying Pan creek and Roaring Fork, with a branch to Aspen, and an extension to Glenwood Springs. It will probably be extended to Utah and it is probable there will be a branch from South Park to the San Luis valley, up the Rio Grande and across the mountains to Silverton It will connect at Colorado Springs with the Denver, Texas & Gulf R. R.

The Denver & Rio Grande R. R. will build an extension from Rock creek to Glenwood Springs and Roaring Fork, with a connection from Glenwood to its Utah line at Grand Junction; branches will be built from Durango to Rico, from Sapinero to Lake City and from Montrose to Ouray; it will probably build from Acequia to Salida. The Denver & Rio Grande Western R. R. will build from a point west of the Colorado river to Rico and Durango. The Denver, Texas & Gulf R. R. is not building at present but will probably complete its line to a connection with the Fort Worth & Denver R. R. at the Canadian river; the latter road having raised money to build to the river. The Missouri Pacific R. R. will build from Salina, Kan., to the Colorado state line and a connection with the Denver, Texas & Gulf R. R. at Manitou Junction, a few miles west of Colorado Springs. The Pueblo & Eastern R. R. Co., has been incorporated by Charles Henkel, H. R. Holbrook, and others, to build from Pueblo to a connection with the Kansas Pacific R. R. and A. T. & S. F. R. R. at the state line, with a branch from West Las Animas to Kit Carson; capital, $1,000.000; offices at Pueblo.

The St. Joseph, Pacific & Grand Island R. R. will be extended from Alma, Neb., to Denver. The San Antonio & Aransas Pass R. R. will ultimately reach from San Antonio, Tex., to Denver. The Texas, Santa Fé & Northern R. R. is completing a line from Santa Fé, N. M., to connect with the Denver & Rio Grande R. R. at Espanola. The Union Pacific R. R. is building a line from Fort Steele, Wyo., to the Grand river, Colorado, where it will connect with the line from Dillon; from the junction a line will extend to Glenwood Springs and Aspen; a line has been surveyed to connect with the Colorado Central R. R. at Graymont; a branch is being built in northern Colorado to connect the line with valuable red stone quarries.